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EXPLORING THE THUNDER CLOUD.

By the Rev. John M. Bacon, F.R.A.S.

Perchance you have lain awake in a draughty seaside lodging when the wind has been rising, and have heard a door in the house banging at intervals at the sport of the wind. Time after time it opens a little way and remains ajar, perhaps for quite a considerable period, when it abruptly "blows to" again. And this provoking performance goes on indefinitely with persistent monotony. The puffs of wind that are responsible for this annoyance, if in an incipient state, will often be found to recur with almost rhythmic regularity. The same phenomenon is noticeable enough out of doors on most days when wind is stirring, but being then less obtrusive generally goes unheeded.

Sometimes, however, the gusts will come on with such impetuous force—like very explosions—that they cannot be ignored. The sailor at sea calls them great guns, and the sailor by sky also learns to take heedful count of them. On a stormy day, during those ticklish few final minutes when a balloon is being "weighed" and adjusted for the start, the heavy gusts that sweep past have to be promptly met, and it is fortunate that their onslaughts are often sufficiently well-timed to allow of their being fully expected.

It is no uncommon event for a thunder storm to arrive with one of these wilder squalls, and in this case it is well known that the motion of the storm as a whole is markedly slower than the average speed of the wind—very commonly a shallow one—which bears it. On another occasion the cloud may be found riding some upper and contrary current, and under these circumstances gives apparent justification for the popular saying that "a thunder storm will come up against the wind." Once this last summer I chanced to be aloft when a disturbance of this nature was brewing, and was able to note the gathering of the storm from the somewhat uncommon point of vantage furnished by a free balloon.

July 27 last was, at least for Newbury and twenty miles round, a day that was characterised by such well marked regular gusts as I have referred to. It also became a typical day of summer storms, and it should be mentioned that the nature of the weather indicated the passage of a well pronounced "secondary," such as is so commonly associated with thunder storms. It is frequently asserted that a characteristic feature of such storms is that the lower sweep of wind which circles over the surface of the ground is very shallow, while at only a moderate height overhead there may be a wholly different drift. This at any rate was the state of affairs as betrayed by the behaviour of the storm I am able to describe.

Before leaving the earth I had entered certain memoranda in my note book, one of which runs thus:—"All through the day weather cocks have been pointing E., while clouds estimated at 2,000 ft. altitude have been scurrying in an opposite direction. The first thunder storm broke over the town at 1 p.m. It was short but severe, the thunder as heard in the main street being as deafening and prolonged as any that I can recall." Another note is to the effect that the oncoming storm approached from due south, and as it burst on our enclosure set the balloon, already filled, spinning in a direction contrary to that of clock hands. Several pilot balloons, which were sent up through the afternoon, and which became invisible before they had reached any great height, went sometimes S.W. and sometimes W., and seemed to hesitate between these two directions.

At 5.15 what was apparently the clearing shower had passed over, and the sky was seen everywhere cloudless up to a great height, the wind on the ground dropping shortly to almost a dead calm. Had any cloudlet been left in evidence at a few hundred feet overhead, or had we at this juncture sent up another pilot, the ascent might have been postponed, or at least the more experienced among us would have altered their opinion about the "clearing shower."

At 5.45 we cast off and leisurely took a N.W. direction heading for Swindon, and thus proceeded till we had covered rather more than a mile in distance, and risen about 700 ft. in height. At this point we abruptly came under the influence of a well defined current which diverted our course to that of the Kennet Valley, trending sensibly due west, and we closely followed up the line of this valley for many miles.

In scarcely more than twenty minutes from the start

a sudden and surprising change took place in our circumstances. Our environment, which had appeared absolutely calm and clear, began changing with the rapidity of a transformation scene. Below us the few hundred feet that separated us from earth began filling in with a blue haze, quite transparent, but growing palpably filmier, while ahead, as also right and left, the horizon at the level of our eye and higher opposed a dense fog barrier of an ashen hue. Overhead of course the sky view was entirely hidden by the huge silken globe. At this period of time we were being swept along on our course, which remained sensibly unaltered in direction, at a speed which we were subsequently able to fix at approximately forty miles an hour.

To ourselves the full significance of these circumstances was not immediately apparent, but the onlookers at our point of departure—the town gas-works, now some five miles in our wake—clearly detected the approach of a heavy thunder pack, and as they reasonably asserted coming against the wind. It towered above the balloon, now seen projected plainly against its face. It came on rapidly and assumed formidable proportions, and there was then the following state of things. The balloon flying due west at the high speed just recorded and, at for five hours continuously; a little way on our right a house was struck and burnt to the ground, and on our left a couple of soldiers were killed on Salisbury Plain.

I would call attention to the fact that though the storm progressed, it also appeared to lag behind the wind that bore it along. I would also lay stress on the further fact that it did not seem to advance against us as a whole, but rather gathered about us, forming itself out of what a few moments before had appeared mere empty and transparent air. Very probably this gathering storm curtain was largely due to the sudden chill which now was very manifest in the air, and which obviously had its origin from above. In the depth below us there was no evidence of any special disturbance, and a parachute dropped from the car about this period floated to the earth steadily and with no divergence.

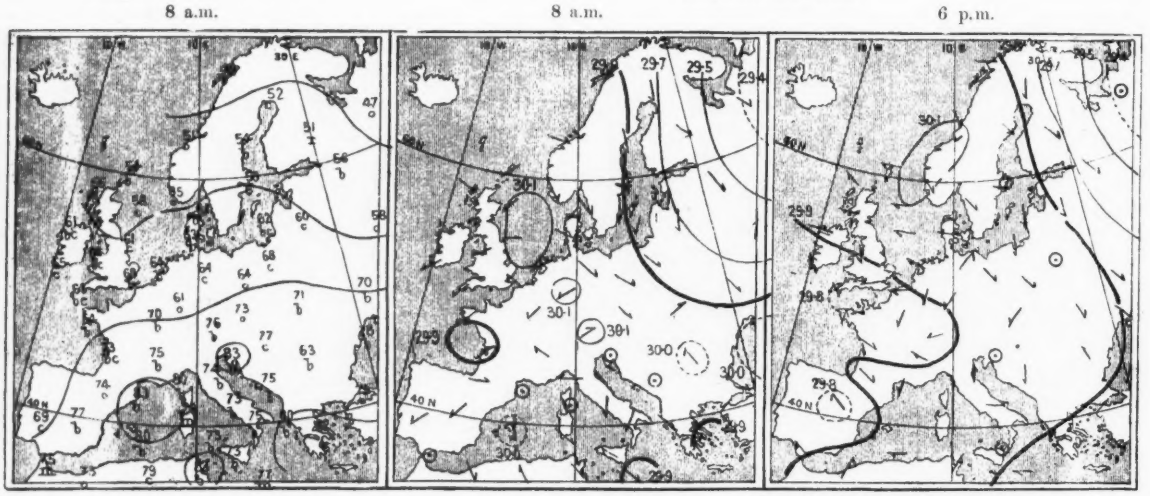
All this may be taken to lend confirmation to the theory that associates thunder storms with sudden and considerable alterations of temperature in contiguous masses of air.

It is worthy of mention that 73 years before an ascent had been made from the same spot at Newbury by the famous Charles Green, under circumstances which it will be seen resembled in many particulars those of the

Friday, 27th July.

Temperature and Weather. 8 a.m.

Barometer and Wind. 8 a.m. 6 p.m.



[From the Charts issued by the Meteorological Office.

apparently no great distance overhead, the thunder cloud progressing at a moderate velocity, not accurately determined but due east or directly opposed to the surface current.

And now with a whistle a blinding sheet of hail attacked the aeronauts, stinging their faces so sharply as to give the idea that the stones were falling from a great height, and immediately afterwards from all sides and close around flashes of lightning shot out with remarkable frequency and vividness. We were, in fact, fairly embosomed in the thunder cloud. Other and near observers narrowly watched the phases of phenomena now in progress. These were the countrymen who became interested spectators, and who presently came to our assistance. They seemed to have imagined that the balloon must be infallibly struck, inasmuch as it appeared to them completely encircled with lightning. It was indeed the worst storm the country side had known for many years. At Devizes, only a few miles ahead, it lasted present occasion. The day was marked by squalls and the ascent postponed until the evening, when the storms gave signs of having cleared off. This appearance, however, was illusory, and the aeronauts presently encountered a thunder storm, the balloon, which had attained an altitude of two miles, being above instead of below the storm cloud. Mr. Green thus describes the situation:—"At this altitude we perceived two immense bodies of clouds operated on by contrary currents of air until at length they became united, and at that moment my ears were assailed with the most awful and long continued peal of thunder I ever heard. These clouds were a full mile below us."

This reverberation of the thunder is worthy of a little consideration. It is to me intelligible enough when it is remembered that the source of sound lay between the balloon and the earth, in which case it only resembled the artificial thunder which I have often evoked by

explosions of gun cotton. In our own experience just cited, however, the lightning flashes which appeared to course between cloud and cloud rather than between cloud and earth were like typical mountain storms followed only by a single short report, and in this resembled phenomena twice observed by Mr. Wise in America. This observant aeronaut on two separate occasions speaks of thunder as "rattling like small arms without any of the rolling reverberations that are heard below." But another significant observation was made by Mr. Wise in both his experiences just referred to. "The thunder pack itself developed uprising cloud columns whose motion resembled that of ebullition in a vast cauldron from whence electric flashes were discharged." With almost the same language he describes the effect presented to him on each occasion when he approached from aloft the neighbourhood of a thunder storm; and Mr. Green in his Newbury ascent already alluded to, uses words that are hardly dissimilar. "I observed," he says, "among other phenomena at every discharge of thunder all the detached pillars of cloud within the distance of a mile round became attracted and appeared to concentrate their force towards the first body of clouds, leaving the atmosphere clear and calm beneath and around us." Neither of the above bygone aeronauts describe to my knowledge any occasion when they have actually found themselves in the heart of a thunderstorm, and in our own case, had there been but fair warning, I think there would have been but little difficulty in avoiding the storm by simply rising above it; but, as I have already sufficiently explained, we were practically without warning from the peculiar manner in which from our restricted point of view the thunder cloud seemed to develop about us out of thin air.

I do not imagine that the smart impact of the hail stones necessarily proved that their origin was far overhead. It is my impression that the hail was being forcibly swept down upon us by a violent downrush of icy air, and as we were counteracting the descent of the balloon by a discharge of ballast our own motion would not reduce the pelting of the storm.

It needs no pointing out that hail is chiefly a phenomenon of the warmer hours of a summer day suggesting that warm moist currents are answerable for its formation, and in this view we may fairly regard the thunder cloud itself as its cradle, and this very frequently at no higher altitude than a mile above the surface of the ground.

The tendency of hail to form with exceptional frequency and severity over certain areas is a local phenomenon which has perhaps hardly met with the attention it deserves, but no facts are more striking or better established. In KNOWLEDGE some years ago it was stated that "within a radius of 12 miles round Somersham Railway Station (Huntingdonshire) hailstorms are so frequent and destructive that all the insurance companies charge double the ordinary rates per acre for crops growing within that district."

The general meteorological conditions prevailing at the time of the storm above described are given in the accompanying charts.

THE INSECTS OF THE SEA.—II.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

SPRING-TAILS.

"WHY the Collembola should be neglected," wrote Dr. Sharp,* in 1895, "when the Thysanura attract so much attention, is as inexplicable as many other fashions are." During the last few years, however, the Spring-tails or Collembola have been receiving a fair share of attention from naturalists, and it seems that the entomological fashion to which Dr. Sharp referred, is destined to show its likeness to other fashions by experiencing a marked change in the near future. The naturalist by the sea-shore at least ought not to neglect the Spring-tails. Smaller and less conspicuous than the Bristle-tail, *Machilis maritima* (described in KNOWLEDGE for January), the marine Spring-tails may be, but they are fairly numerous in species, and some of them are more perfectly adapted than Machilis for a marine life.

Spring-tails resemble Bristle-tails in being entirely without a trace of wings, and have often been united with them in the order Thysanura (to which it has lately been suggested to restore the Linnean title Aptera). But the divergence between the two groups is in many respects so striking that Lord Avebury's separation† of the Spring-tails as a special order, to which he applied the name Collembola, seems to be fully justified. The name (*Κόλλα, glue*, and *ἐμβολή a throwing in*) refers to the supposed function of the "ventral tube"—a very characteristic organ of these insects, situated beneath the first segment of the hind body (Fig. 1, *v. t.*); it shelters two protrusible processes which may help the insects to cling to smooth surfaces, or may possibly, like the abdominal sacs of Machilis, serve as breathing organs. This tube is unknown among the Bristle-tails, and there are other and more conspicuous differences between the two groups. The hind-body of a Spring-tail has never more than six evident segments, and long "tail-bristles" like those of the tenth abdominal segment in the Thysanura are never present. The feelers, always with very numerous segments among the Bristle-tails, have never more than six distinct segments among the Spring-tails.

The reduction in the number of abdominal segments from ten to six marks the Spring-tails as a less primitive group than the Bristle-tails. And their specialization is further shown by the possession of that very remarkable organ—the "spring"—which gives them their English name. The spring (Fig.1, *s*), which may be borne beneath either of the fourth or fifth abdominal segment, roughly resembles a two-pronged fork, consisting of a single basal piece—the "handle" (*manubrium*), to which are attached two long, flexible tapering "teeth" (*dentes*); at the end of each tooth is articulated a little "point" or tip (*mucro*) which is not always sharp. It is likely that this spring has been formed by the fusion of a pair of abdominal limbs. It may be tucked beneath the body pointing forwards, as the insect runs along; when it is released and straightened out so that the tip points backwards, the Spring-tail leaps into the air. Let the reader lift a stone under which a colony of Spring-tails are sheltering, and he will have full demonstration of their leaping powers. (See Fig. 1.)

There is a family of Spring-tails, the Sminthuridæ—having, however, no marine representative—with compact globular hind-body; these insects breathe by means of a set of air-tubes opening by paired air-holes on the head—an altogether exceptional position. But most Spring-tails have no air-tubes at all; they breathe entirely through the skin. Adaptation to an aquatic life is,

* "The Cambridge Natural History," Vol. V., p. 190.

† Sir John Lubbock. "Monograph of the Collembola and Thysanura." London (*Ray Society*), 1873.

therefore, easy to them. Many species are found on the marshy shores or on the surface of the waters of lakes and ponds, and quite a fair number will reward the researches of the seaside entomologist.

Several species of the genus Isotoma, for example, may be found jumping about among the cast-up seaweed at highwater mark. Some of these are of interest since they occur indifferently in inland and sea-shore localities. Isotoma belongs to the Entomobrydæ—the most typical family of the Spring-tails—characterised by a well-developed spring (borne on the fifth abdominal segment), a very small front fore-body segment (prothorax), and a clearly segmented hind-body. The species of Isotoma are not scaly as many Spring-tails are, but are clothed with numerous hairs, sometimes also with bristles. The hind-body segments are equal in length or almost so. *Isotoma palustris* (Müller) is one of our commonest Spring-tails, occurring among herbage in marshy places, and by the edges of ponds. But this species may also be found among seaweed, and a dark, violet-brown variety, haunting the coasts of the Baltic, has been named *fucicola* by Drs. Reuter and Schött.‡ This particular variety, however, is known to occur in Scotland by inland bogs. Such indifference on the part of the same insect to marshy or sea-shore surroundings is highly instructive, for it shows us a Spring-tail of the land in the act of establishing itself along the tidal margin. *Isotoma littoralis*, described by Prof. Moniez,§ from the French coasts of the Channel, is probably a form of this species. "It is very common," he writes, "under the fucus which clothes the rocks uncovered at each tide. It runs very quickly beneath this shelter, leaps with the greatest ease, and takes refuge readily among the fronds of seaweeds or the shells of barnacles, when it is disturbed."

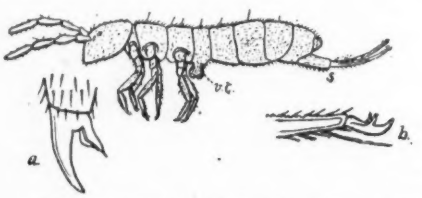


Fig. 1.—*Isotoma maritima*. Magnified 25 times. (*s*, spring; *v. t.*, ventral tube). *a*, foot-claws; *b*, tip of spring, magnified 140 times.

Another, much rarer Isotoma, *I. maritima*, Tullberg (Fig. 1), first discovered on the Swedish coast, has lately been found both on the eastern and western shores of Scotland by Mr. W. Evans.‖ The teeth of the spring in this species are very long and slender; if the end of the tooth be examined under the microscope, the thin pointed tip, and the long stiff bristle characteristic of the species can be made out (Fig. 1, *b*). *I. maritima* occurs on the shores of the Baltic, the North Sea, and the French coast of the Channel, but, despite its name, it is not exclusively a maritime insect. It inhabits Bohemia, and the Bohemia of modern geography, unlike that of Shakespeare's "Winter's Tale," has no sea-coast. Here, it seems, we have an insect, already almost restricted to the shore line, but still lingering on in the heart of the continent.

Two other scarce shore-haunting Spring-tails—*Isotoma crassicauda*, Tullberg, and *I. Schötti*, Dalla Torre (*littoralis*, Schött) (Fig. 2), offer a great contrast in form to *I. maritima*, as their spring-teeth are remarkably short and thick, and bear blunt, stumpy tips which differ somewhat in form in the two species (Fig. 2, *b*, *c*). *I. crassicauda* is found on the coasts of Sweden, Finland, the Shetland Isles, and northern France, while *I. Schötti*, until its recent discovery at the mouth of the Elbe and on the western Irish and eastern Scottish shores, was known only from Finland, Sweden, and Spitzbergen. Like *Machilis maritima*, therefore, these marine Spring-tails tell us of a former coast line stretching northwards from our British area, and *I. Schötti* yields evidence for the extension of this ancient shore far into the Arctic seas.

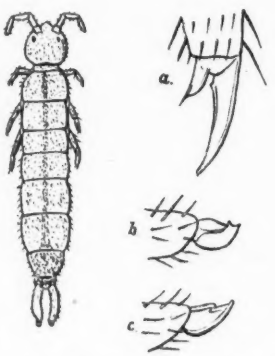


Fig. 2 — *Isotoma Schötti*, magnified 20 times. *a*, foot-claws; *b*, tip of spring, magnified 140 times; *c*, tip of spring of *I. crassicauda*, magnified 140 times.

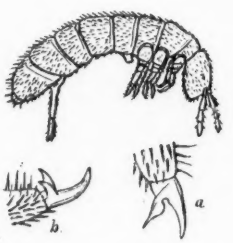


Fig. 3.—*Isotoma Beselsii*, magnified 20 times. *a*, foot-claws; *b*, tip of spring, magnified 120 times.

Still further light is thrown on these problems of ancient geography by yet another rare Isotoma, lately found by Mr. Evans among wrack on the shores of the Firth of Forth. Resembling the two last-mentioned species in its short, thick spring-teeth, this one is easily distinguished by its very remarkable spring-tip. (Fig. 3, *b*.) Except for its single North British locality, and its occurrence on the coast of New England, its known range is altogether Arctic. Like some other, more imposing animals, it has received a different name from well-nigh every naturalist who has seen it. Lord Avebury and M. Stscherbakov described it almost simultaneously in 1898 from Spitzbergen—the former as *I. spitzbergenensis*, the latter as *I. arctica*. Last year M. Wahlgren called specimens from the lonely arctic islet of Jan Mayen, *I. janmayensis*. But it appears that Prof. Packard, so long ago as 1873, had described the same insect from Polaris Bay, Greenland, as *I. Beselsii*,¶ which is apparently the name by which we shall have to know it. The scattered points where this little insect has occurred help us to trace our old continental coast-line north of the Atlantic westward to American shores.

‡ H. Schött. "Zur Systematik und Verbreitung palæarctischer Collembola." *Kongl. Svensk. Akad. Handl.*, Vol. XXV., No. 11, 1893, 100 pp., 7 pls.

§ R. Moniez. "Acariens et Insectes marins des Côtes du Boulonnais." *Rev. Biol. N. France*, Vol. II., 1890, pp. 324–6.

‖ G. H. Carpenter and W. Evans. "The Collembola and Thysanura of the Edinburgh District." *Proc. R. Phys. Soc. Edin.*, Vol. XIV., 1899, pp. 221–266, pls. V.–VIII.

¶ C. Schäffer. "Die Arktischen und Subarktischen Collembola" (in Römer and Schaudinn's "Fauna Arctica"). Jena, 1900.

Distinguished from the family of Isotoma by the relatively large prothorax, the frequent reduction of the ventral tube to a mere tubercle, and the presence of the spring (if one be present) on the fourth segment of the hind-body, the Poduridæ form the lowest of the three families of Spring-tails. They are lowly not because they are primitive but because they are degenerate. Among the genera of this family the spring can be traced through all stages of degradation until it vanishes altogether, and we have a paradox—like many another equally instructive in zoology—a Spring-tail without a spring.

The genus Achorutes, however, is characterised by the presence of a well-developed spring, and its most abundant species, *A. viaticus*, Tullberg, seems to be, in certain places at least, the commonest of all the insects of our coasts. Like *Isotoma palustris* mentioned above, it also abounds in many inland localities. Colonies may be found sheltering in moss, or disporting themselves on the top of a wall, or cooling themselves in a marshy hollow, or luxuriating in a rotten turnip. But they may often be found in numbers among the cast-up seaweed, and sometimes on the sea-sands they occur in vast myriads. At Aberlady, near Edinburgh, in September, 1896, Mr. Evans found these Spring-tails, 2000 or 3000 to the square foot, for several hundred yards along the shore of the Bay. The foreign range of the species stamps it as a dominant race. It is known to occur from Siberia to California, from Spitzbergen and Greenland to Tierra del Fuego.

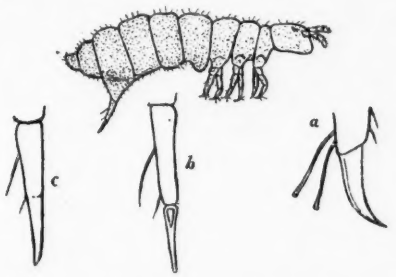


FIG. 4.—*Xenylla humicola*, magnified 20 times. *a*, foot-claw; *b*, tooth and tip of spring, magnified 120 times; *c*, tooth and tip of spring of *X. maritima*, magnified 120 times.

Two rare kinds of marine Spring-tails belong to the genus *Xenylla*, which is distinguished from Achorutes by the presence of only one claw on the foot instead of two. These insects are deep blue-black in colour. One of them, *X. humicola*, O. Fab. (Fig. 4), until its recent discovery on the North German and Scottish coasts, was known only from Arctic localities—Greenland, Novaya Zemlya, and Finland. Its long tapering spring-tip is very characteristic (Fig. 4, *b*). The other species, *X. maritima*, Tullb., has occurred on the shores of Finland, Sweden, and Ireland. It furnishes an interesting stage in the degeneration of the spring, since the spring-tip is not clearly separated from the tooth which bears it, the two being fused into a single pointed process (Fig. 4, *c*). Though often found among rotting wrack, Xenylla is, despite its name, far from exclusively maritime, since it inhabits the kingdom of Wurtemburg, and has been found in northern Germany beneath the bark of trees.

Very similar in aspect to Xenylla is another blue-black insect, *Anurida maritima* (Guér.) (Fig. 5), when seen with the unaided eye walking over rocks or tangled masses of seaweed. But Anurida is one of those Podurid genera in which the spring is wanting; a glance with a

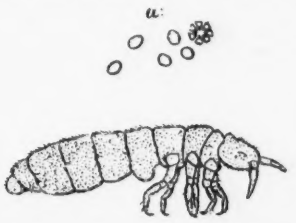


FIG. 5.—*Anurida maritima*, magnified 20 times. *a*, eyes and post-antennal organ of right side, highly magnified.

lens enables one, therefore, readily to distinguish this common insect from its scarce relation Xenylla. In its perfect adaptation to a saltwater home, *Anurida maritima* is the most characteristic of all our marine Spring-tails.** For it seems never to be found except between the tide-marks, and may often be observed in large companies on the surface of rock-pools. The insects' presence here, however, is, according to the observations of Prof. Moniez, involuntary. When the tide rises they shelter in crevices of the rocks, among seaweed, or in empty shells—wherever they can undergo immersion without getting washed away. The last shock of the waves as the tide recedes, often carries them out of such shelters on to the surface of the pools, where they collect together in large masses, climbing over one another. By the force of the wind, the living mass may be carried to the edge of the pool; then the outside individuals at once do their best to clamber up the rocks, never seeking to regain the sea, though sometimes an insect may, despite its efforts, fall once again into the water. The skin of Anurida is covered with numerous very minute tubercles; these ensure that the surface film shall not be broken, and thus prevent the insect from getting wetted. Even a submerged individual is surrounded by a layer of air, a gleaming silvery bubble being visible through the water.

As if to compensate them for the loss of the spring, these lowly Podurids have a mysterious sense-organ on either side of the head, between the feelers and the eyes, which attains a high degree of complexity. In some of the less degenerate Spring-tails—Isotoma, for example—this organ consists of a simple elongate-oval depression, but in the Podurids we find within the depression a number of minute prominences, usually regularly arranged and of a remarkably complex form. In *Anurida maritima*, these prominences are seven in number, and somewhat resemble the lights of a circular window (Fig. 5, *a*). From the recent researches of M. Willem,†† it seems that the structure of these prominences and of the connected nerve-endings show that smell is the function of the "post-antennal" organ. Some Podurids (Xenylla, for example) have eyes but no post-antennal organs; others (as Lipura) post-antennal organs but no eyes. Anurida rejoices in both.

Probably *Anurida maritima* is common all round the rocky parts of our coasts. It also inhabits the shores of France and Heligoland, but it has not been traced into

** A. Laboulbène. "Recherches sur l'Anurida maritimæ." *Ann. Soc. Ent. France* (4), Vol. IV., 1864.

†† V. Willem. "Les Yeux et les Organes post-antennaires des Collemboles." *Ann. Soc. Entom. Belg.*, Vol. XLI., 1897, pp. 225-6.

northern or Arctic regions. Nevertheless it reappears on the Atlantic sea-board of North America, and American zoologists have made its life-history the subject of detailed and careful study. Like all the Spring-tails and Bristle-tails, Anurida passes through no transformation after hatching; the tiny insect leaves the egg in a form closely like that of its parent. But the development of Anurida within the egg forms the theme of several valuable embryological researches‡‡ by Profs. Ryder and Wheeler, Miss Claypole, and Dr. J. W. Folsom. With a notice of one or two important points brought out by these investigators our study of marine Spring-tails may fitly close.

The earliest study of the growth of Anurida (Prof. Ryder's) established the interesting fact that a rudiment of the lost spring exists in the embryo, and a vestige of the organ is still present when the insect is hatched. We thus have sure evidence that the absence of the spring in the adult is due to degeneration, as there can be no doubt that, in such a matter as this, the life-history of the individual represents approximately that of the race.

In our account of the Bristle-Tail, *Machilis maritima*, the possible near relationship of primitive insects to primitive crustaceans was discussed. Every one knows, however, that while most crustaceans have two pairs of feelers on the head, insects have only one pair. But there are several insects in whose embryos a vestigial pair of appendages between the feelers and the mandibles have been observed. Anurida is one of these. At a very early stage in the progress of growth, a pair of tiny processes (Fig. 6, A, *tc*) bud out from the germ band behind the feelers. There can be no reasonable doubt that these represent a second pair of feelers, lost by all

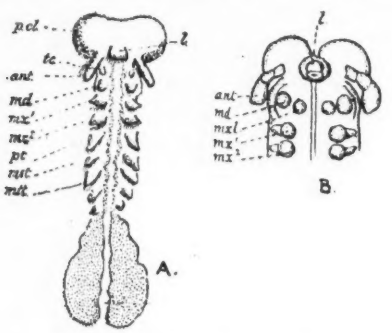


Fig. 6.—A.—Early embryo of Anurida. (After Wheeler.) *l*, upper lip; *ant*, feelers; *tc*, vestigial appendages; *md*, mandibles; mx^1, mx^2, first and second maxillæ; *pt*, *mst*, *mtt*, the three pairs of legs. B.—Head region of later embryo. (After Folsom.) *mxl*, rudiments of maxillulæ; other lettering as in A. Highly magnified.

living insects, but retained by the great majority of crustaceans.

An important structural point wherein Spring-tails agree with Bristle-tails is the possession of the paired organs at the base of the tongue—the "maxillulæ" (*see* p. 21, *ante*), believed by Dr. Hansen to represent the first maxillæ of crustaceans. Now Dr. Folsom, the most recent student of the growth of *Anurida maritima*, has traced the development of these organs in great detail. He finds that they arise from a pair of rudiments (Fig. 6, B, *mxl.*) situated between the mandibles, altogether similar to the rudiments of the other paired limbs, and having a nerve-centre (ganglion) and a division of the primitive body cavity (coelom) associated with them. There seems, therefore, no doubt that a primitive segment with paired limbs, between the mandibles and maxillæ, is indicated by the method of growth as well as by the developed structures; and further support is thus accorded to the relationship between early insects and crustaceans to which reference has already been made.

Thus we see that minute details in the obscure life-history of these humble insects of the sea-shore—details only to be learnt by long and careful research—help us to trace the history and relationships of some of the largest and most important classes of the Animal Kingdom.

‡‡ J. A. Ryder. "The Development of Anurida maritima." *Amer. Nat.*, Vol. XX., 1886, pp. 299–302, pl. XV.

W. M. Wheeler. "A Contribution to Insect Embryology." *Journ. Morph.*, Vol. VIII., 1893, pp. 1–160, pls. I.–VI.

A. M. Claypole. "The Embryology and Oogenesis of Anurida maritima." *Journ. Morph.*, Vol. XIV., 1898, pp. 219–300, pls. XX.–XXV.

J. W. Folsom. "The Development of the Mouth Parts of Anurida." *Bull. Mus. Comp. Zool. Harvard*, Vol. XXXVI., 1900, pp. 87–158, pls. I.–VIII.

RAINFALL IN SOUTH AFRICA.

By Arthur H. Bell.

The presence of so many of our troops in South Africa, as well as so many others of our countrymen who may be contemplating a prolonged sojourn there, renders the subject of the climate in which they are living an important one; and of all the elements likely to have an effect on the development and future prospects of the country none will be so far reaching as rainfall. Indeed differences in climate, after all, prove to be barriers which separate different races of men from one another, and questions of temperature may, in the long run, be found to regulate the extent to which any given class of men may advance into untried regions of the earth. At times it seems to be assumed that the Anglo-Saxon race may with impunity settle down in any quarter of the globe whatsoever, and may do so without experiencing any physiological inconvenience from submitting bodily functions and organisms to a climate to which they are unsuited. A hot moist climate may, however, prove more effective in limiting the peregrinations of adventurous races than the artifices of diplomacy or a complete equipment of modern armaments. This possibility renders the vagaries of climates in distant parts of the globe of permanent interest, and, as stated above, an important matter for consideration at the present moment is as to whether past meteorological records throw any light on the future prospects as regards rainfall in South Africa. To those who daily experience the comfort of having four brick walls between the wind and their nobility the changes in the weather are of comparatively little moment; but in opening up a new country there is much camping out to be done, and those whose lot it is to sleep under canvas are likely to find the question of rainfall an important one. Fortunately a very excellent series of rainfall observations is available for elucidating the subject, for such observations have been made in South Africa at a very large number of stations and during a large number of years, the stations being distributed over a wide area of

country. The following figures are taken from a paper which appeared in the "Quarterly Journal" of the Royal Meteorological Society, and are based on the published reports of the Cape Town Meteorological Commission.

For the present purpose it will be convenient to divide the Cape Peninsula into three areas, namely, the Western Division, the Eastern Division, and Natal. The stations to which reference will be made cover an area which extends from Cape Town to Durban, and reaches as far north as Kimberley; and they are, moreover, at various heights above the sea level, and represent climates of places which like Simons Town is only 20 ft. in height, and others like Aliwal North which has an altitude of 4400 ft. Now there is a very wide range in the yearly rainfall in these various localities, and as regards the yearly averages the records show that the values range from 54.17 ins. at Bishop's Court, in the Western Division, to 8.36 ins. at Camfer's Kraal in the Eastern Division. Taking individual years, as much as 82.82 ins. has fallen during twelve months at Durban, but, on the other hand, at Camfer's Kraal the rain-gauge during a certain year only succeeded in collecting rain to the amount of 3.10 ins. The most obvious fact, therefore, as regards the rainfall in South Africa, is its lack of uniformity, and not only do the amounts vary from one locality to another but there is also a lack of symmetry from year to year. In respect of the individual districts the average yearly fall over the Western area is 27.34 ins.; over the Eastern, 17.06 ins.; and in Natal, 38.21 ins., the average for all stations combined being 22.44 ins. Along mountain ranges such as Table Mountain in the Cape Peninsula, and along the Katberg and Amatola Mountains, the yearly fall varies from 50 to 70 ins. In parts covered with forests, as in T'Ztyikama on the south coast, and in Natal, the range is from 30 to 50 ins. A strip of country along the mountains near and parallel to the coast in the eastern division of Cape Colony has an average yearly fall of from 20 to 30 ins.; and a band of country along the inland side of Molepolola in Bechuanaland has from 10 to 20 ins.; while in a patch of country in the Great Karro lying between Zwarteberg and the Nieuwvelt Mountains and the extreme north-west regions of Cape Colony, the average yearly fall is under 5 ins.

The three districts mentioned above are, of course, drained by the Orange and Vaal rivers, and it has been calculated that they discharge into the ocean 900,000,000,000 cubic feet of water during the year. In the future administration of the country, therefore, not the least of the important problems to be solved will be those connected with devising some scheme whereby this abundant supply of water may be stored by suitable reservoirs and irrigation works, and thus rendered available for developing the agricultural resources of the country. From this point of view, those who concern themselves with collecting rainfall statistics may be encouraged to continue their labours, for in the work connected with the opening up of new countries such statistics are of the highest value.

As a means of further illustrating the variation to be observed in the amount of rain which falls in different parts of South Africa, a table is appended which shows for a few selected stations the mean yearly rainfall together with the total rainfall measured during the wettest and the driest years experienced during the period in which the observations were made, a period which is in no case less than ten years. The height of each station above the level of the sea is given in brackets.

	Wettest.	Driest.	Mean Yearly Rainfall.
WESTERN DIVISION.	Inches.	Inches.	Inches.
Simons Town (20)	37·35	23·09	30·89
Bishops Court (250)	77·87	38·08	54·17
Wynberg (250)	68·50	27·47	42·23
Worcester (780)	24·32	5·33	12·40
Capetown (50)	43·10	17·70	26·95
EASTERN DIVISION.			
Kimberley (3950)	30·30	9·34	16·58
Aliwal North (4400)	31·93	17·00	24·35
Brakfontein (4100)	15·91	3·52	9·76
Graff Reinet (2500)	24·30	6·96	14·78
Rietfontein (2270)	22·03	5·09	11·51
Queenstown (3500)	28·34	12·66	20·83
Somerset East (2500)	38·64	11·32	22·82
Lower Nels Poort (3100)	16·58	4·48	10·15
Port Elizabeth (180)	33·65	15·31	23·16
Camfer's Kraal (3000)	13·81	3·10	8·36
NATAL.			
Pietermaritzburg (2100)	50·98	22·41	34·46
Gardenscliffe (2270)	46·18	25·95	37·14
Durban (130)	82·82	28·24	43·17

THE SIZE OF OCEAN WAVES.—II.

By VAUGHAN CORNISH, M.SC.(VICT.), F.C.S., F.R.G.S.,
Associate of the Owens College.

Paris states that wind can create waves which move faster than itself, but adds that when the sea is rough the waves are always slower than the wind. He endeavours to find a relation between the velocity of wind and that of waves, but when he has eliminated all "swells," all observations in rather shallow water, and all cases where there appeared to be circumstances interfering with the required conditions, there remain only 31 days' observation on which to found a generalisation. The observations on these days give the velocity of the wave proportional to the square root of the velocity of the wind. He explicitly states, however, that the number of observations is too few for the establishment of an empirical law, and wishes for the accumulation of a large mass of data, which, if carefully discussed, might show whether the above relationship is merely accidental, or if, on the other hand, it is general.

More interesting, perhaps, are the two tables (II. and III.), in which are grouped on two different plans

TABLE II.

Observations by Lieut. Paris.

State of the Sea.	Av. Veloc. Wind. Feet per Sec.	Av. Veloc. Wave. Feet per Sec.	Ratio Veloc. Wind to Veloc. Wave.	Av. Height. Feet.	Av. Length. Feet.	Ratio Length to Height.	Av. Period. Secs.
Très-grosse mer	93·51	56·43	1·66	25·43	485·6	19·1	8·6
Grosse mer	65·62	45·93	1·43	16·57	347·8	21·0	7·6
Mer dure, clapoteuse, fatigante, etc.	43·96	41·01	1·07	11·65	252·6	21·6	6·2
Grosse houle	30·18	45·28	0·67	13·45	393·7	29·3	8·7
Houle	19·36	39·04	0·50	7·87	255·9	32·5	6·5
Belle mer	18·70	35·43	0·51	5·25	203·4	38·7	5·7

the observations of the whole 4000 waves. In Table II. the grouping is without regard to locality, being

simply according to the "state of the sea." Only the mean values are here reproduced from the original

Table III.

Observations by Lieut. Paris.

Region.	Av. Veloc. Wind. Feet per Second.	Av. Veloc. Wind. Feet per Second.	Mean Ratio Veloc. Wind to Veloc. Wave.	Av. Height. Feet.	Av. Length. Feet.	Mean Ratio.* Length to Height.	Av. Period of Waves. Seconds.
Atlantic Trades ...	15·75	36·75	0·43	6·23	213·3	35·2	5·8
South Atlantic (Region of the West Winds)...	44·29	45·93	0·96	14·11	436·4	31·0	9·5
Southern Indian Ocean	57·09	49·21	1·16	17·39	374·0	21·5	7·6
Indian Trades ...	21·33	41·34	0·52	9·19	315·0	35·3	7·6
Seas of China and Japan	47·90	37·40	1·28	10·50	259·2	24·7	6·9
Western Pacific...	27·89	40·68	0·68	10·17	334·7	33·0	8·2

* This column cannot be calculated from the two preceding columns.

table. In Table III. the *same* observations are grouped geographically. The first question which occurs to one is whether another cruise would give similar waves in the same areas. Fortunately we can compare the heights of the waves with those observed (about 1837 A.D.) on the voyage of the *Astrolabe*, of which a summary was published in 1866 (*Comptes rendus des séances de l'Acad. des sciences*, Vol. LXII.), by M. Coupvent des Bois, who was himself a member of the expedition. The method of observing the height of the waves was the same as that adopted by Paris. The velocity of the wind is also given but does not seem to be comparable with Paris' numbers. The verbal description of the state of the weather is, however, some guide in this case. (Table IV.) The average height of the waves in the trade winds of the Atlantic

Table IV.

Observations on the *Astrolabe*

Scale of Numbers.	State of Weather.	Velocity of Wind. Feet per Second.
0	Calme moyen	3.28
1	Faible brise	9·84
2	Petite brise	16·4
3	Jolie brise	26·25
4	Belle brise	42·65
5	Forte brise	68·9
6	Grand frais	108·27
7	Tempête	164·04
8	Ouragan	239·51

It will be noticed that velocities for strong winds are quite out of accord with Paris' determinations given in Table I.

and Indian Oceans is very nearly the same in the two cases. The largest waves were met with on both voyages in the southern Indian Ocean. The results for the Pacific Ocean differ much; I doubt, however, if the area included by Paris under "Pacific west," is the same as the western part of the "Océan Pacifique équatorial" of Des Bois, so that the difference of results may have but little physical significance.

Des Bois' method of grouping the waves in longitudinal strips of 30° is convenient. In the equatorial Pacific (0° to 30° lat.) the mean force of wind and the mean height of the waves diminished from east to west, being near the Asiatic coast only $\frac{1}{4}$ to $\frac{1}{3}$ of the height near the American coast. In the equatorial Indian Ocean the winds and waves were highest in the middle. In the equatorial Atlantic the waves were highest on the western side, although the winds were strongest in the east. In the centre there was a medium height of wave combined with the lowest force of wind. In the latitudes 60°-66° S. we note the strongest winds with relatively low waves. I suspect that the relatively small height of wave is due to floating ice, which, as Nordenskiold has pointed out, has a marked effect in smoothing the sea. The total number of observations was about 7200. I infer from the text that the height of the waves was not actually measured at each observation, but that sufficient measurements were taken to satisfy the person responsible for the work as to the height of wave which corresponded with the entry "state of the sea." This state of the sea was noted six times daily, each such note constituting, I suppose, one "observation," from which the average heights given in Table V. were afterwards

Table V.

Observations on the *Astrolabe*.

Compare last column with column 4 of Table II.

	Long.	Velocity of Wind. Feet per Second.		Height of Waves in Feet.	
Equatorial Pacific Ocean (0°—30° lat.)	75-110W	15·42	av. 13·45	11·48	av. 5·69
	110-140 „	13·78		6·56	
	140-170 „	14·44		4·92	
	170W-160E	13·45		3·94	
	160-130E	13·12		3·94	
	130-100 „	10·50		3·28	
Equatorial Indian Ocean (0°—30° lat.)	120-90 „	15·75	av. 19·14	6·89	av. 8·42
	90-60 „	25·92		11·81	
	60-30 „	15·75		6·56	
Equatorial Atlantic Ocean (0°—30° lat.)	10E.-11W.	18·70	av. 15·75	4·26	av. 6·12
	10W.-30 „	13·45		6·56	
	30—50 „	15·09		7·55	
30°—50°	? All longitudes		14·11		7·22
50°—60° S.	Méridien d'Amerique	15·09	av. 17.06	6·89	av. 10·67
50°—60° S.	Méridien Nouvelle-Hollande	19·03		14·44	
60°-64° S.	Méridien d'Amerique	24·94	av. 24·45	6·89	av. 6·89
60°—66° S.	Méridien Nouvelle-Hollande	23·95		6·89	

calculated. This connection between "state of the sea" and height of wave, found by measurement, is given in Table VI. This should be compared with Paris' Table III.

The following observations of waves were made by the Hon. Ralph Abercromby* on board the s.s. *Tongariro*, in various parts of the South Pacific, between New Zealand and Cape Horn, in 1885. The observations of height were made with the aid of a $4\frac{1}{2}$ inch aneroid, with a very open scale divided to 0.01 of an inch. Altitudes were calculated on the assumption that 0.001 inch difference of pressure corresponds to

* Observations on the Height, Length, and Velocity of Ocean Waves, read before the Physical Society, February 25th, 1888, published in the *Philosophical Magazine*, April, 1888 (Vol. XXV., 5th Series).

1 foot height. It was considered that the errors of height due to the aneroid were never more than 2 to

TABLE VI.

Observations on the *Astrolabe*.

Numbers recorded in the Log.	State of Sea.	Height of Waves in Feet.
7	Très-grosse mer	28·54
6	Grosse mer	20·67
5	Très-grosse houle	15·42
4	Grande houle	10·83
3	Houle	7·55
2	Petite houle	4·92
1	Belle mer	3·28
0	Mer unie	1·97

Compare with columns 1 and 5 of Table II.

2.5 feet. The greatest source of error in the opinion of the observer occurred in the estimation of the height of the eye above sea level. For instance, he says, when the aneroid was at its lowest point the surface of the water might be 10 feet below the eye; but when the crest of the wave was passing, the height might be reduced to 1 or 2 feet. Here the observer had to trust to estimation by the eye aided by a few rough measurements with a piece of string down the ship's side, and the error here, he considers, may be at least 2 feet either way, or 4 feet in all. Observations for length and speed were taken in much the same way as those of Paris, with the advantage, however, of a flyback chronograph over an ordinary second's hand watch. Abercromby mentions two difficulties in obtaining good results, viz., that two successive waves rarely ran in exactly the same direction, and that, with a heavy following sea the ship yawed about so much that the angle between her course and that of the waves could only be estimated approximately. Really big waves were met with on only 3 days. On June 8th, 1885, in lat. 47° S., long. 175° W., the sea was too irregular to measure individual wave heights or lengths, but the barometer indicated about 12.5 feet vertical motion of the point of observation below decks. The surface of the sea was pretty constantly about 7 feet below the port-hole in the troughs, and 1 foot at the crests. This gives an average height of the waves 18.5 feet. The velocity of the waves was pretty constant, although the length appeared to be so irregular, five observations giving speeds of 29, 28, 31, 33 and 30 miles per hour (average 30.2 miles). On June 10th, in lat. 51° S., long. 160° W., the observer availing himself of the previous determination, assumed a constant difference of six feet between the height of the aneroid above water level at crest and trough, and added this to the observed variation of the aneroid. Individual waves were observed with heights of 26, 21, 23.5 and 26 feet, but the indication of the aneroid indicated that the difference of absolute level between the lowest trough and the highest crest (not one of those recorded above) was 35 feet. I suppose the inference from this to be that the difference, if a real one, was due to the presence of a long swell susceptible but not visible in the rough sea, and I apprehend that the revelation of such invisible but not negligible waves is one of the special advantages of the aneroid over eye observation. The velocity and length of waves was measured just before the heights were taken; three determinations gave the following results:—

Velocity.		Length.
32	miles per hour. ...	507 feet.
35	„ ...	470 „
39·5	„ ...	—
28·5	„ ...	358 „

This sea, Abercromby says, would have been logged as 6 or 7 on the ordinary scale of 0—8, while the wind was blowing a moderate to hard gale from N.W. with heavy squalls, and was logged 7 on Beaufort's scale of 0—12. During some of the squalls the force rose to 8; the sea, he says, might be taken as a fair average in the South Pacific, the waves were far too irregular to allow of any attempt being made to determine the ratio of height to length or velocity. On July 16th, 1885, lat. 55° S., long. 105° W., larger waves were observed during which the greatest vertical lift of the aneroid in the cabin was undoubtedly 40 feet. If the difference of water level outside was again 6 feet the height of the waves was 46 feet, but of this the observer, who confined his attention to the aneroid, was not sure. The measured velocities and lengths were:—

Velocity.		Length.
35·5	miles per hour. ...	445 feet.
35·5	„ ...	485 „
47·5	„ ...	765 „

The author states that the want of harmony between the length and velocity on the one hand, and the height on the other, was not due to errors of observation. On all the days the waves were running irregularly; he did not see any crests nearly a mile long chasing one another with a well defined trough between. There was nothing to call a cross sea, but there were many series of waves of different lengths running pretty much in the same direction which were constantly interfering with one another. He generalises from his experience (which it must be mentioned were by no means confined to the voyage of which he here speaks) in the statement that the great discrepancies in the observed elements of waves given by different observers is doubtless due to the co-existence of several series of undulations, which, therefore, always make a more or less confused sea.

The author concludes with suggestions for a wave-measuring party, which he says should be composed of three members, A, B, and C. C would have charge of two chronographs, and B of the aneroid. They would confine their attention to reading the instruments, whilst A only would watch the sea. He would observe the arrival and passage of the wave crests, the height of the water against the ship (by marks on the side) at crest and trough, and he might have to read a simple clinometer also to allow for the roll of the ship.

(To be continued.)

CONSTELLATION STUDIES.

By E. WALTER MAUNDER, F.R.A.S.

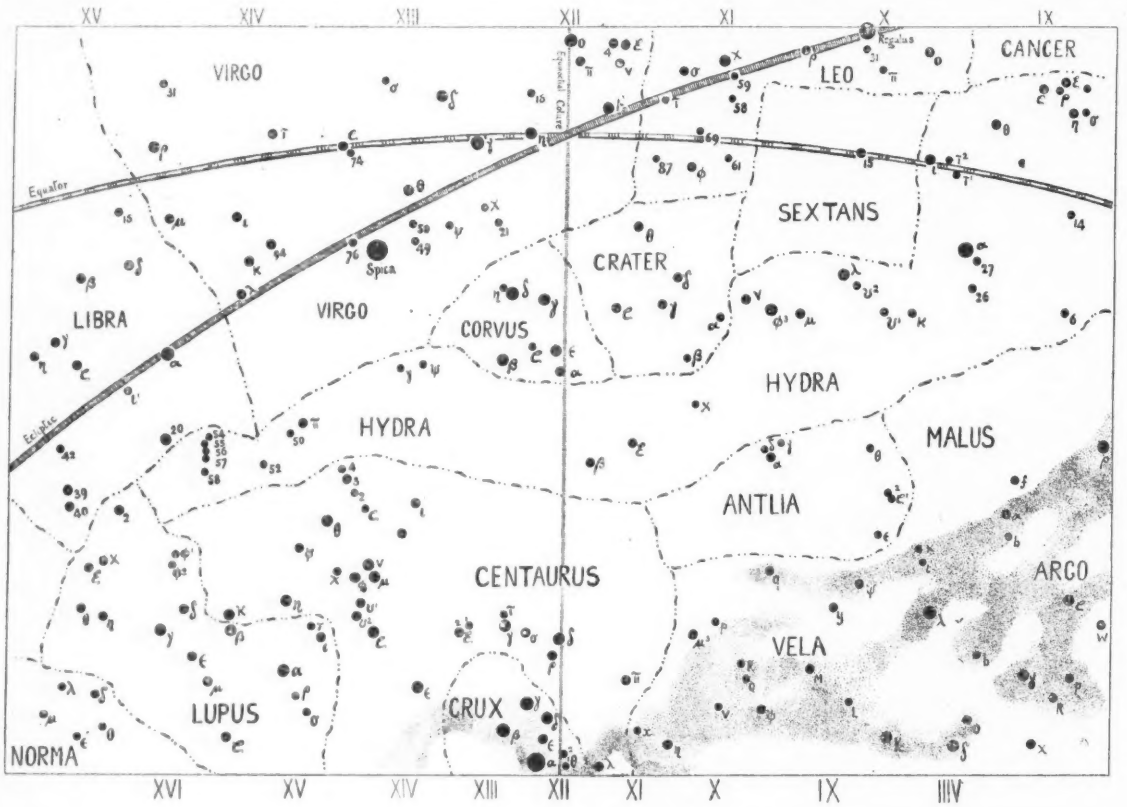
III.—THE REGION OF VIRGO.

THE Great Bear still holds the zenith at midnight throughout the month of March, but by the middle of the month the Lion has ceased to be the dominant constellation in the south. Its place is taken by the Virgin, which seems almost to lie below the royal beast, for at this time of the year the ecliptic curves downwards more sharply than at any other period, for its descending node lies close to the boundary of Leo and Virgo and just within the latter constellation. Virgo, therefore, is easily found when Leo is known, or the old rhyming direction will plainly point it out:—

"From the Pole Star through Mizar glide
With long and rapid flight,
Descend, and see the Virgin's spike
Diffuse its vernal light,
And mark what glorious forms are made
By the gold harvest's ears,
With Deneb west, Arcturus north,
A triangle appears;"

Denebola of the Lion's tail forming an equilateral triangle with Arcturus and Spica, the principal star of the Virgin.

The chief stars of the Virgin, six in number, make an irregular capital Y, lying on its side, the stem and lower branch of the Y very nearly marking the ecliptic. That great circle is particularly clearly marked out in this portion of the heavens. Delta in the Twins,—the bright star below Pollux, and marking that hero's right hand; Delta in Cancer, the southern of the two asses; Regulus



Star Map No. 3; The Region of Virgo.

in Leo are all almost exactly on the ecliptic, and Rho and Tau, two fainter stars in Leo, carry on the line to the boundaries of Virgo. Within that constellation the line runs a little south of Beta, Eta, and Gamma, which form the right branch of the Y, and a little north of Spica (Alpha Virginis). Whilst a fourth magnitude star, Lambda, as far beyond Spica as Spica is from Gamma, marks almost the precise point where the ecliptic runs into Libra. The upper branch of the Y is marked by Delta and Epsilon. Gamma the star which marks where the Y forks, is one of the most celebrated of double stars.

Aratus gives more space to the history of this constellation than to any other. With him, she is Astraea, the spirit of Justice, once in the Golden Age a dweller amongst men. But when an inferior race in the Silver Age succeeded to their fathers, she withdrew to the mountains, and fled thence to the sky when the Brazen Race fashioned murderous weapons and devoured the flesh of plough oxen for their food. The account of her which is still most generally received, is that she represents the wheat harvest; the ear of corn in her hand, which one would have thought a fitter symbol of sowing, being taken as representing the garnered sheaves. But this cannot be the case, for Aratus tells us—

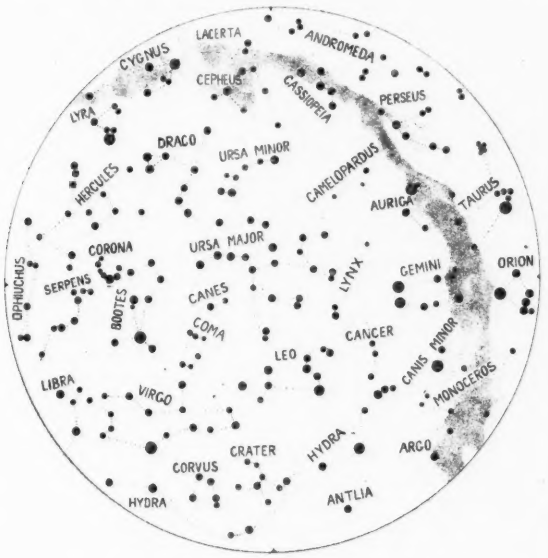
"As rushing on his prey,
The lordly Lion greets the God of day,
When out of Cancer, in his torrid car
Borne high, he shoots his arrows from afar,
Scorching the empty fields and thirsty plain,
Secures the barn the harvest's golden grain;"

proving, as Brown points out, that Spica was not associated originally with the harvest, since this had been already reaped when the sun entered the Lion. A further proof is afforded by the old name of Epsilon Virginis, "Herald of the Vintage," the vintage necessarily falling considerably later in the year than the harvest.

The constellations of the Zodiac, if intended to mark the several months of the year, should, being twelve in number, stretch each of them over 30° of longitude, neither more nor less. As a matter of fact they are of most irregular length, Cancer extending only over 18° or 19°, whilst Virgo covers about 50°. At an early period, therefore, the ecliptic was divided into twelve equal portions, not constellations, and having no direct con-

nection with the actual arrangement of the stars, but deriving their names from the constellations which most nearly corresponded to them. These were the Signs of the Zodiac as distinguished from the Constellations of the Zodiac, and the distinction between the two is one that it is important to bear in mind. The months of the year never did, and never could have corresponded with the actual constellations; the Signs, being purely arbitrary divisions, could always be made to correspond with the months. Since, then, the constellation figures are clearly older than the equal signs, it is manifest that none of the many schemes which have been framed to account for the Signs of the Zodiac by the climatic changes of the successive months in this or that country can have any basis in fact. The constellation figures were in existence long before the correlation of signs and months was effected.

The Accadian calendar connects the sixth sign of the Zodiac with Ishtar, the "daughter of heaven," the moon in one aspect, and the planet Venus in her two-fold



The Midnight Sky for London, 1901, March 7.

character of morning and evening star in another. Early Christian thought recognized a reference to the promise of "the Seed of the Woman" of Genesis iii. 15, in "the ear of the corn" the Virgin carries in her hand, and the expression in Shakespeare's play of Titus Andronicus, "the good boy in Virgo's lap," refers to the mediæval representation of the sign as the Madonna and Child.

The region of the sky enclosed between the two arms of the Y, and Denebola of Leo, lies near the pole of the Galaxy, and is the wonderful Nebulous Region. Here these strange bodies are to be found by the hundred, clustering more thickly than in any other portion of the sky.

Close below Virgo are two small but fairly bright constellations, the Cup and the Crow; the Cup lying underneath the Virgin's shoulder, the Crow beneath her hand. The latter constellation is very easily found; Delta Corvi forms with Alpha and Gamma Virginis almost an equilateral triangle, and the line from Alpha Virginis to Delta Corvi leads to Gamma Corvi. When on the meridian, two other stars of about equal brightness, Epsilon and Beta, lie below Gamma and Delta and make up with them a neat little trapezium. Beta Virginis and Delta Corvi make a rough equatorial triangle with Delta Crateris, the brightest star in the centre of the Cup, a somewhat fainter group than that of the Crow. Four stars in a semi-circle, of which Delta is the middle one, mark the bowl of the Cup. These two little groups are commonly represented as actually intermingled with a huge, winding snake, the longest constellation in the sky, Hydra, which stretches across some 95° of longitude. Its head begins close to Procyon, under Cancer, and it stretches below the zodiacal constellations of Cancer, Leo and Virgo and the greater part of Libra. It has few bright stars, and these not grouped in easily remembered figures; and the great reaches of barren sky it includes seem referred to in the name, given to its brightest star, Alphard, The "Solitary." Alphard may be readily found by prolonging a straight line from Gamma Leonis through Regulus, and dropping a perpendicular on it from Procyon. The myths connected with the three constellations have no very great interest. Brown finds Hydra, a "storm-and-ocean-monster." "The quick flowing rivers seem to have been compared by the Akkadii with the swift gliding of a huge glistening serpent, and so we arrive at the idea of the River of the Snake, which develops into an Okeanos' stream, like the Norse great serpent," the Midgard Snake. The Cup becomes thus a "symbol of the vault of heaven wherein at times storm, wind, clouds, rain are chaotically mixed"; and the Crow, or rather Raven, is the constellation of the Storm-Bird. Carl G. Schwartz, who, at the beginning of this century interpreted the constellations as being a sort of symbolical geography of the countries on the west shore of the Caspian, thought these three constellations represented the petroleum wells of Baku. The great extent of the Hydra, with its folds and knots, show, beyond mistake, in his opinion, the slow oily flow of crude petroleum; the Cup is placed there to indicate the liquid which would have to be held in a cup or some such reservoir, whilst the Crow indicates its inky blackness!

Of these three constellations, Crater is perhaps the best for opera-glass examination, yielding some pretty fields. Zeta Corvi, the faint star nearly midway between Epsilon and Beta, shows with the opera-glass as an interesting little double, whilst a much closer pair will be found near Beta and slightly preceding it.

Erratum.—In column 2, page 34, of the February number of Knowledge, the eighth line from the bottom is to be omitted.

TOTAL SOLAR ECLIPSES OF THE TWENTIETH CENTURY.

By A. C. D. Crommelin.

Standing as we do on the threshold of a new century, it seems a fitting occasion to examine what opportunities it will afford of witnessing that grandest of celestial phenomena—a total solar eclipse—and of unravelling the mysteries which still hang thickly about the sun and his surroundings. It is clear that eclipses visible in Europe are especially interesting to us, for they are accessible to a much greater number, and afford opportunity for more complete series of observations. I have prepared a diagram showing the tracks of all the total eclipses that cross Europe or the regions adjoining it during the coming century. These tracks do not claim absolute accuracy, but they are very near the truth. I have in

each case calculated as many points as seemed necessary from the Tables in Oppolzer's Canon, and then drawn the track through them by hand, except for the eclipses of 1914, 1927, 1999, for which I have made use of the elements given by Dr. Hind in "Nature," Vols. XII., XIII., XXXI., and that of 1905, for which I have made use of a map published by the Madrid Observatory.

Two European countries seem especially favoured at present, viz., Spain and Norway. Spain has had total eclipses in 1842, 1860, 1870; it had one in the past year, and others in 1905, 1912. Norway has had them in 1816, 1851, 1896, and has others in 1914, 1927, 1945, 1954.

I commence with the eclipse of August 30th, 1905, which is a very favourable one, the track being 2½ times as broad and the duration 2½ times as long as that of the past year.

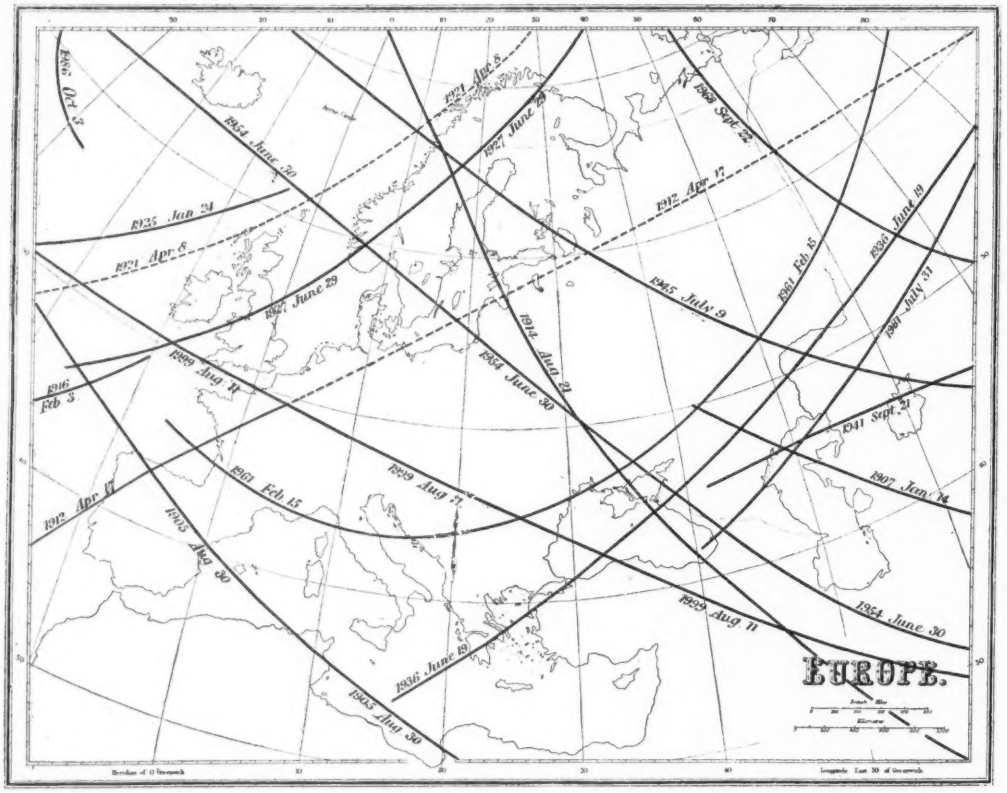


Diagram showing the Tracks of all Total Solar Eclipses that cross Europe during the Twentieth Century.

The central line runs from Viavelez in Oviedo to Torreblanca, passing close to Burgos, which will be a very convenient and accessible station to view it from, the duration of totality there being 3m. 47s., a very unusual amount for a European eclipse. The width of the track is about 120 miles; the southern limit runs approximately from Corunna to Valencia, the northern one from a little west of Santander to somewhat south of Tarragona. This eclipse may also be observed in Labrador, the Balearic Isles and Tunis.

Passing over the eclipse of 1907, which is total soon after sunrise on the shores of the Caspian, we come to that of 1912. This belongs to that rather rare class of eclipses which are total near the middle of the shadow track but annular at the beginning and end. The track enters Portugal near Aveiro and runs north-east, leaving Spain some 12 miles east of Gijon. It then traverses France, passing very near Paris, and across Belgium, Germany and Russia. In Portugal there will be about 7 seconds of totality, in the west of France a second or two, and further east the eclipse will be only annular.

Short as the totality is in Portugal it should be possible to obtain photographs of the inner corona, and the flash spectrum may be photographed round the whole limb of the sun, which should yield results of great interest and value.

The eclipse of 1914 crosses Norway, Sweden and Russia. The central line enters Norway at Alstahoug in latitude 66°, the duration of totality being two minutes. It runs south-east, intersects the railway running east from Trondhjem, leaves Sweden near Bramon I., intersects several islands in the Baltic, and then takes a course across Russia from Riga to the Crimea. Those who journey by sea have thus the choice of four distinct coasts, in addition to the islands.

The eclipse of 1916 ends near the south coast of Ireland. The track of totality passes very near to, and may actually intersect, the island of Corvo in the Azores, so that this may be available as an observing station. If not, it will be necessary to go to Guadaloupe or Venezuela.

The eclipse of 1921 is inserted in the map, though only an annular one, since it is the next central eclipse in the British Isles. The last total eclipse in the British Isles was in 1724, but there were annular eclipses in

1836, 1847, 1858. The central line in 1921 crosses the island of Lewis, and onwards to the Lofoden Islands.

The eclipse of 1925 is total near Boston, U.S.A., but does not appear to touch land on this side of the Atlantic.

In 1927 we have the next totality in the British Isles. The central line runs from near Anglesea to North Yorkshire, where totality will last about 21 seconds. Dr. Hind gives it as nine seconds, but this seems to me to be clearly too small. The track then goes right up the backbone of Norway, and passes out near Vadso, which was occupied as an eclipse station in 1896, and may again be occupied, as the duration of totality there is considerably longer than in southern Norway; our weather experiences in 1896, however, were not very encouraging.

The eclipse of 1936 may be well observed from Constantinople; that of 1945 from Norway, Sweden or Finland.

In 1954 we may have another totality in the British Isles, as Dr. Hind considered that the northernmost of the Shetlands would lie within the shadow track; in any case it will be observable in southern Norway.*

The remaining eclipses do not need much comment. The eclipse of 1961 may be well observed in Italy and Turkey. In 1966 there will be a very brief totality in Greece. It is not shown on the map. In 1999 occurs the third totality of the century in the British Isles, and the most favourable of all.

The north limit of totality passes approximately through Tintagel Head, Exmouth and Weymouth; the central line from St. Ives (Cornwall) to Prawle Point. Hence the shadow will cover nearly the whole of Cornwall and the southern portion of Devon. The duration of totality will be just two minutes. This eclipse will also be visible in North France (the central line runs from St. Valery to Laon), Germany, Austria and Turkey.

Many interesting illustrations of the Saros cycle or period of 18 years 11 days, after which eclipses recur, may be derived from our eclipse map. This cycle was explained in an article by Mr. Walter Maunder in Knowledge for 1893, Vol. XVI., p. 181. Each recurring eclipse moves westward about 120° of longitude, so that after 54 years we get an eclipse in about the same longitude, but north or south of the first according as the Moon is at a Descending or Ascending Node.

The eclipses of 1882 (Egypt), 1900 (Spain), 1918 (United States), 1936 (Greece), 1954 (Shetlands), are an example of an eclipse moving slowly northward.

Again, the eclipse of 1860 was visible in Spain; after three more Saroses it crosses Norway in 1914, while three more bring it to north-east Russia in 1968; after one more return in 1986 west of Iceland this eclipse ceases to be total.

As an example of a southward moving eclipse, that of 1851 was total in South Norway; after three Saroses it crosses Spain in 1905, while in 1959 it will cross the Sahara.

Again, the eclipse of 1927 returns in 1945, and after three more Saroses it gives us that of 1999.

While conveying a general idea of the locality where an eclipse will recur, the Saros is not exact enough to predict the track of a future eclipse with great precision. Major-General Strahan, in his report on the Indian eclipse of 1898, attempts to predict the eclipses of the next century by the Saros cycle alone, but many of his tracks (*e.g.*, 1961) are considerably in error.

It would be useless to completely classify the non-European totalities for 100 years, but the more important eclipses of the next 30 years, some of which have been already mentioned, are given in the following list:—

1901. Mauritius, Sumatra, New Guinea (long totality).
1904. Pacific Ocean (long totality).
1905. Labrador, Spain, Tunis, Egypt.
1907. Caspian, Turkestan, Mongolia.
1908. Pacific.
1911. Pacific.
1912. South America (Bogota to Rio Janeiro).*
1918. North America (Vancouver to Florida).
1919. Brazil, Gold Coast, Lake Tanganika (long totality).
1922. Australia (long totality).
1923. North America (San Francisco to Jamaica).
1925. North America (Lake Superior to Boston).
1926. Victoria Nyanza, Amirante Islands, Sumatra.
1929. Sumatra, Malay Peninsula, Philippines.

The next thirty years afford on the whole a more favourable series of eclipses than the last thirty years, and as many of them are in reasonably accessible localities, it is to be hoped that they will be extensively observed, and unravel many problems of solar physics that are still veiled in mystery.

* I am informed by Rev. S. J. Johnson that Dr. Hind subsequently concluded that the shadow would not touch the Shetlands, but would lie further North.

* There will thus in 1912 be two total eclipses six months apart, which is a very rare occurrence.

SUNRISE ON THE SEA OF PLENTY.

By E. Walter Maunder, F.R.A.S.

The region of the Moon shown in the present plate, which is taken from the fourth number of the magnificent Atlas Photographique de la Lune, published by the Paris Observatory, exhibits under the double influence of strong foreshortening and sunrise illumination, a striking amount of relief; and the nearness of the terminator to the limb accentuates a feature, common indeed to the whole lunar surface, but here seen most strikingly, namely the tendency for the chief formations to dispose themselves along meridians. Thus we find the narrow strait of light, lying between the terminator and the limb, is almost exactly bisected by a succession of great walled plains,—Petavius, Vendelinus and Langrenus,—all on the 60th meridian. This meridian in its sweep northward, traces out the western boundary of the Mare Fecunditatis, cuts through the ring-plains, Webb and Apollonius, and bisects the Mare Crisium. In this latter Mare, we see the influence of these meridianal forces marked in still greater detail, since it is crossed by a number of ridges,—one of which is especially distinct on the photograph,—which streak it from north to south; a clear indication that the tidal attraction of the earth when the moon's crust was still in a plastic condition, was a chief agent in moulding the surface into its present shape.

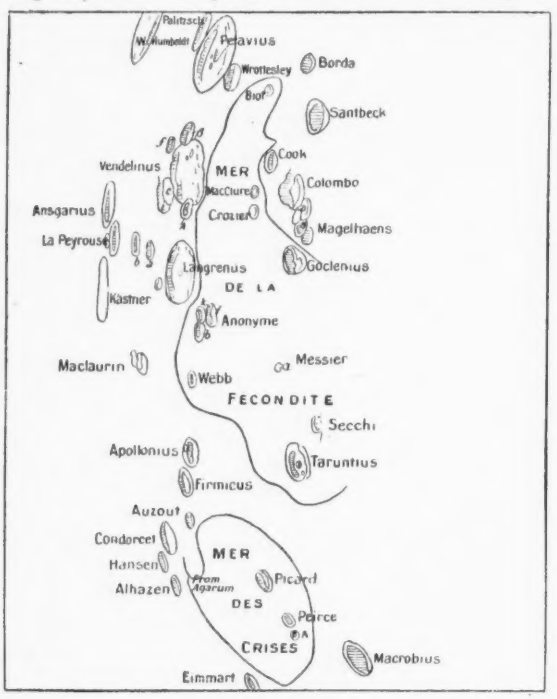
The Sea of Conflicts, from the beauty of its surroundings and the strong relief into which it is thrown whilst the crescent moon is still young, has always been a favourite object of study. Its size too is convenient; it can be examined as a whole, and the definiteness of its outline makes it the more suitable for such study. In length, east and west, it reaches to 355 miles, whilst its

length, north and south, is but 280. It is thus elliptical in reality, as it is also in appearance, but its major axis, through the effect of foreshortening, shows as if it were the minor.

The Mare Crisium was the subject of the Plate in Knowledge for March, 1899, two years ago; but it was then shown under sunset illumination, whilst in the present Plate, the morning light is full upon it. The western border, therefore, was entirely lost in night in the former representation, and the eastern highlands were too strongly illuminated for their intricacies to be followed as clearly as they can be now. The magnificent mountain group which forms the southern boundary of the Mare, can also be examined better under the present lighting; its broad deep bays and winding valleys being seen under the most favourable conditions.

The western frontier is quite of a different character from the others, being a broad, gently sloping plateau; and the extension on the west of the Mare which begins under the shelter of the great southern promontory, Cape Agarum, and which appears on the photograph to be marked off from the main body of the Mare by a very distinct ridge, would seem probably to be a later development, an annexation after it had attained its original form of a nearly perfect hexagon.

The centre of the Plate is occupied by the Sea of Plenty, which however is not shown here quite in its entirety. It covers an area of 160 thousand square miles, stretching some 640 miles from north to south, 410 from east to west. It narrows, however, greatly towards the south, being only 130 miles wide where Vendelinus borders it, so that its shape as a whole is that of a pear. The photograph brings out in strong relief the successive ridges by which the plain rises from its lowest depth,—



Sketch Map.

situated almost precisely at the centre of the Plate,—up to its western border, and which mark the stages of the subsidence of the crust.

Immediately to the west of the Mare, is the beautiful walled plain of Langrenus, which in the completeness of the example which it offers of eruptive action may be considered the Copernicus of this region of the moon, and indeed it is not much inferior to the latter in perfectness of outline, whilst it considerably exceeds it in dimensions. The walls of Langrenus, however, do not rival those of Copernicus in height, and its system of light streaks falls far short of that which crowns the beauty of the monarch of the Carpathians. The great walled plain at the top of the photograph is Petavius, nearly 80 miles in diameter, surrounded by a lofty mountain wall, double on nearly every side but the north, where it is lower and broader. Two of the leading features of the formation come out on the photograph with especial distinctness; one the central peak, and the other the rill that leads from it in a south-easterly direction, right up to the wall of the plain.

Between Petavius and Langrenus lies Vendelinus, a walled plain as extensive as its two neighbours, but destitute of their symmetry and completeness, but for that very reason a more interesting region to study. Midway between Petavius and Vendelinus, but further from the limb, is Petavius B, a deep ring plain, standing in a bright elevated region. The brightness of this region renders it one of the most conspicuous markings in the Plate, and is an evidence of its relative newness.

A very cursory glance at the limb of the Moon is sufficient to show that it is far from being a true curve, a very distinct flattening being very perceptible about the centre. This is of especial interest, inasmuch as it gives some suggestion of an answer to the question we so vainly ask, "What does the other side of the moon look like?" It would seem that we have here another of the great grey plains which on the visible disk we call *maria*. It is the Mare Smythii, and its presence justifies us in inferring that the unseen three-sevenths of the moon's spherical surface does not materially differ in general character from the four-sevenths we know. Like it, it would present, could we examine it, bright broken highlands and broad sombre plains, and every variety of lunar structure from the great walled plain to the smallest craterlet.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE PATH OF THE SUN.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In the notice of my work under the above title in your January issue, an adverse opinion is expressed, and with your permission I desire to suggest a reference to facts of such a character that they will either effectually destroy my theory of the Sun's course or establish its truth.

Just as it is essential for the truth of precession that the south pole of the heavens should describe a similar circle to that of the north pole, so is it requisite for the establishment of my case that the south pole should not move in a circle but remain in one spot; and if proof of its motion can be furnished, I will admit the fallacy of my arguments.

If, on the contrary, observations show that the south pole is a fixture, no other theory but mine can account for such a phenomenon; nor can the doctrine of precession be maintained in face of a fact so contradictory.

I will only add that while abundance of evidence exists as to the present position and revolution of the north

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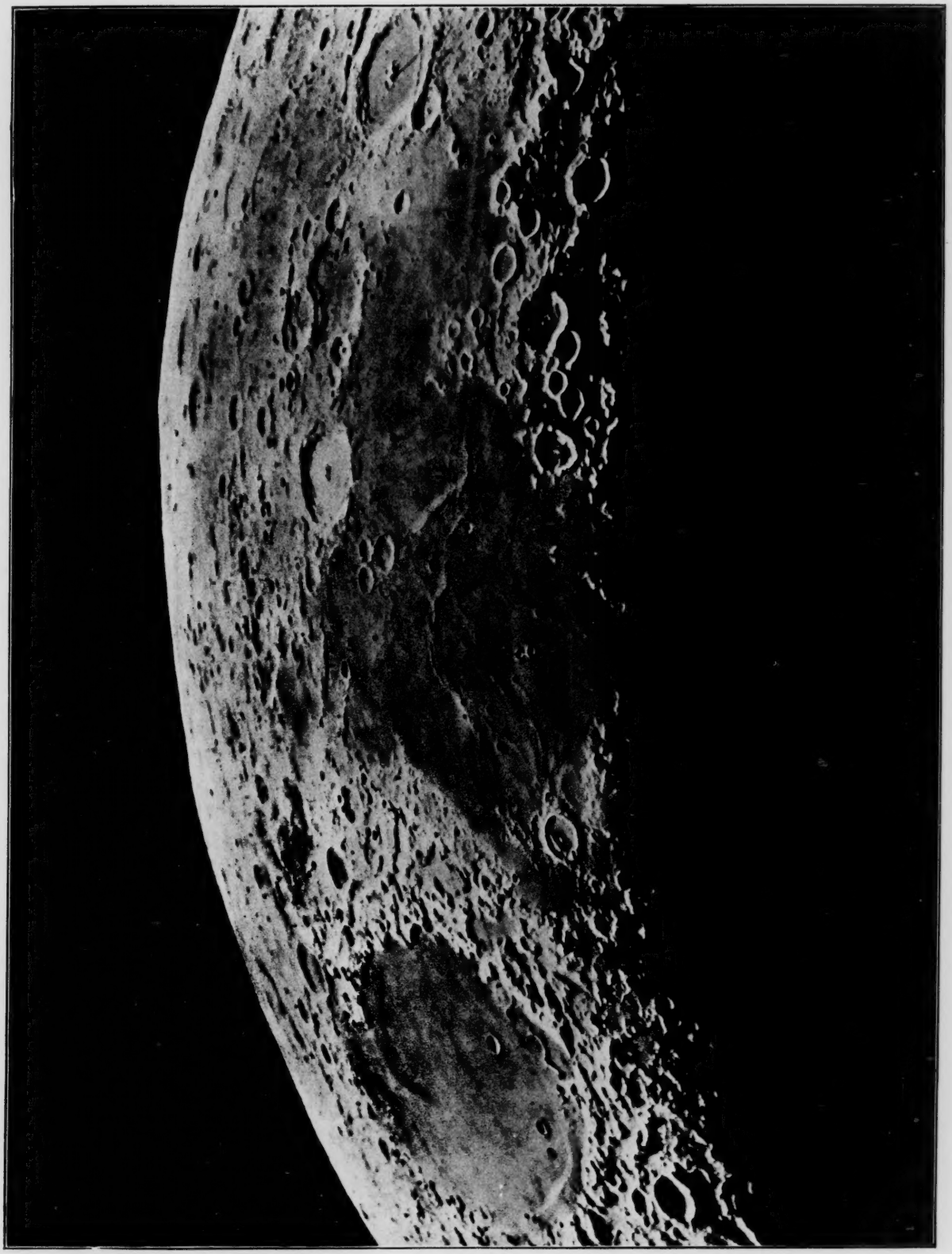
SOUTH.



WEST. EAST.

NORTH.

SUNRISE ON THE SEA OF PLENTY.

From a Photograph taken 1897, March 7th, 6·5h. Paris Mean Time, with the Great Equatorial Coudé of the Paris Observatory.
Scale:—Diameter of Moon, 22 inches. Moon's Age, 4d. 6·4h.

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pole, all we are told of the south pole is that it is in a certain place, and I desire an answer to the question, Does it remain there? WM. SANDEMAN.

14th January, 1901.

[It is rather extraordinary that Mr. Sandeman, after having studied this subject for so many years, and writing so confidently upon it, should never have applied so simple a test to his theory himself. It is still more extraordinary that he should assume that astronomers who have been observing accurately the places of the southern stars for a century and a half have not yet ascertained whether they showed the effects of precession or not. However, the answer is simple; the south pole of the heavens moves in exact accordance with the north pole. A pair of stars taken from the neighbourhood of each pole will show this clearly. Nos. 6 and 1634 of Bradley's Catalogue are in R.A. 0h. and 12h., and are distant from the north pole 13° and 12° respectively. β Hydri and γ Muscæ have similar R.A.'s, and are distant from the south pole 12° and 18° respectively. Now if we compare Lacaille's Catalogue for 1750 with the Cape Catalogue for 1890; and Bradley's Catalogue reduced to 1750, with the Radcliffe Catalogue for 1890, we get the following apparent changes in the places of the stars due to the actual motion of the poles.

	R.A. 1750.	R.A. 1890.	Diff.	S.P.D. 1750.	S.P.D. 1890.	Diff.
	h. m. s.	h. m. s.	m. s.	° ′ ″	° ′ ″	′ ″
β Hydri	0 12 12·0	0 19 55·3	+7 43·3	11 20 12	12 7 34	+47 22
γ Muscæ	12 17 51·6	12 25 54·2	+7 59·6	19 15 7	18 28 29	−46 38
	R.A. 1750.	R.A. 1890	Diff.	N.P.D. 1750	N.P.D. 1890.	Diff.
	h. m. s.	h. m. s.	m. s.	° ′ ″	° ′ ″	′ ″
Bradley 6	0 2 31·3	0 9 59·6	+7 28·3	14 26 23	13 39 38	−46 45
Bradley 1634	12 0 6·7	12 7 2·2	+6 55·5	10 59 37	11 46 21	+46 46

The figures show that the north pole has moved in the 140 years about 47′ downward towards Bradley 6, whilst the south pole has moved away from β Hydri on the same meridian, almost exactly the same distance.—THE REVIEWER.]

SUNSET PHENOMENON.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Before the rains started here at the beginning of summer a strange phenomenon was occasionally observed at sunset. From a point in the east, exactly opposite where the sun was disappearing below the horizon, rays of light streamed out, extending a considerable distance. It looked just as though the sun had gone down in the wrong place, and when there were rays from both east and west the effect was very striking. Can you give me an explanation in one of the numbers of the paper?

P.O. Box 66, R. L. MCDONALD.
Bulawayo, Rhodesia,
10th January, 1901.

[The phenomenon is essentially of the same character as the familiar one which children call "the sun drinking," when, in somewhat hazy weather, the shadows of clouds stand out in the moisture-laden air. So, under certain circumstances, about a quarter of an hour after the sun has gone down, we may occasionally see similar shadows apparently radiating from the Sun's place. These are likewise the shadows of clouds thrown upon the air full of moisture or of dust. The beams are in reality parallel straight lines, but from the effect of perspective they seem to radiate from the sun's place, and to converge again to a point directly opposite to it. It is, however, rare for them to be traced entirely across the sky, and as the air overhead is necessarily freer from the minute particles which make the beams evident, they can very seldom be traced across the zenith, even when they are seen near their converging point in the east.—E. WALTER MAUNDER.]

NOTES.

ASTRONOMICAL.—At the annual meeting of the Royal Astronomical Society on February 8th, the Gold Medal of the Society was awarded to Prof. E. C. Pickering, the well-known able and energetic Director of the Observatory of Harvard College. In the course of a letter expressing his appreciation of the honour, Prof Pickering made the interesting announcement that with an instrument of only 8 inches aperture, he is now able to photograph the spectra of stars down to the 13th magnitude.

Professor W. W. Campbell, who is well known for his astrophysical researches, has been appointed Director of the Lick Observatory, in succession to the late Prof. J. E. Keeler.

The observations made by the members of the Variable Star Section of the B. A. A. indicate that the observed phases of Beta Lyræ fall a little later than the calculated phases as published in the *Companion to the Observatory*, the difference being perhaps 1·4 days.

The preliminary reports of the British official parties who observed the solar eclipse last May have recently been issued by the Royal and Royal Astronomical Societies. They show that although perhaps no striking discoveries were made, a vast number of valuable records of the phenomena were secured. Mr. Newall attaches some importance to the fact that the moon was darker than the sky, thus suggesting that some of the light usually attributed to the sky comes from beyond the moon. Mr. Evershed concludes that the "flash" spectrum is as constant a feature as the Fraunhofer spectrum itself.—A. F.

ENTOMOLOGICAL.—Some interesting observations on the growth and development of instinct in spiders have been recently published by Miss A. B. Sargent (*Proc. Acad. Nat. Sci., Philadelpia*, 1900, pp. 395-411). The species studied were a large orb-weaving spider *Argiope*, and the common long-legged tube-weaving spider of North America, *Agelena naevia*. (Our British *A. labyrinthica* is well-known to arachnologists.) Almost all mother spiders surround their eggs with a silken cocoon, in which the young spend the first few weeks of their lives after hatching. Miss Sargent concludes that the main object of this cocoon is to prevent evaporation of moisture from the young spiders, and that it serves in a less degree as a protection against enemies, such as wasps and ichneumon-flies. The young spiders were kept under observation through the winter, and it was found that they could endure a large amount of cold and damp, but that warm dry surroundings killed them. When associated together in the cocoon the young Argiope were always found to rest with the ventral surface outwards, perhaps to facilitate respiration by presenting the breathing holes to the outer air. In the development of the senses, touch seems to be shown earliest, and light and darkness are distinguished before the form of objects can be made out. The earliest "psychical" manifestations made by the young spiders were interpreted as indicating fear. While still in their "little nests," young spiders seem to live harmoniously together, but the individuals of an Agelena family were eager to eat one another when they had begun to make their own way in the world.—G. H. C.

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Zoological.—The micro-organism of distemper in the dog is described by Mr. M. C. Potter in the *Proceedings* of the Royal Society. It is shown that a culture can readily be produced, which there is good hope will lead to a very considerable mitigation of the disease in question.

For several years Herr G. Tornier has been studying examples of lizards, newts, and frogs with double tails or additional limbs, and has shown (*Zool. Anzeiger*, 1897-98) how such abnormalities can be produced artificially. In his most recent contribution to the subject (*Ibid.*, 1900, No. 614) he figures several newts showing various types of bifid tail, and describes in detail the manner in which regeneration of the tail produces such abnormalities.

Mr. Walter Rothschild's long-expected monograph of the cassowaries, together with Mr. W. P. Pycraft's dissertation on the structure and relationships of the ostrich-like birds, has just been published in the *Transactions* of the Zoological Society, illustrated by no less than eighteen coloured plates. It is a magnificent piece of work, admirably carried out from first to last. Eight species of cassowaries, which naturally fall into three groups, are recognised, several of them being divisible into a larger or smaller number of local races. Morphologists will, of course, be most interested in Mr. Pycraft's communication. In his opinion, the Ratitæ (or, as he prefers to call them, Palæognathæ) have diverged in several separate branches from points very low down in the avian stem, which is continued upwards to split up into the various groups of Carinatæ (Neognathæ). It is, however, difficult to realise how these birds became flightless comparatively so soon after the acquisition of wings by the class in general. And it is still less easy to understand how the Ratitæ can be so much older than the cretaceous Carinates of the United States as the author considers to be the case. All the available palæontological evidence (especially as Mr. Pycraft excludes the eocene *Gastornis* and *Diatryma* from the Ratite group) points exactly in the opposite direction.

The attention of all interested in the molluscs and brachiopods of the British seas should be directed to a classified list of species drawn up by a committee of experts and published in the January number of the *Journal of Conchology*. The nomenclature appears to have been revised with great care, and it may be hoped that its publication will tend to promote uniformity in this respect among conchologists.

A most interesting exhibit is now on view in the Central Hall of the Natural History Museum. It consists of a wax model of the African tsetse fly, enlarged to the dimensions of a big bat. Alongside are models of red blood-corpuscles, enlarged to the dimensions of medium-sized biscuits, and between them two models, on a similar scale, of the tsetse parasite. The whole exhibit is beautifully executed and most instructive.

According to the investigations of Miss Lee, of which an abstract appears in a recent issue of the *Proceedings* of the Royal Society, the skull-capacity of a large number of individuals does not tend to support the theory that relative brain-weight, either in the individual or in the sex, is associated with relative intellectual power. It is stated that "one of the most distinguished of Continental anthropologists has less skull-capacity than 50 per cent. of the women students of Bedford College; one of our leading English anatomists less than 25 per cent. of the same students."

Notices of Books.

"By Land and Sky." By the Rev. John M. Bacon, M.A., F.R.A.S. (Isbister & Co.) Illustrated. 7s. 6d.—Mr. Bacon's book will probably be read more for its living interest and spirit of adventure than for its scientific qualities. His narratives of balloon ascents by others and himself, and his descriptions of observations made under these and other conditions, possess the personal and general characteristics appreciated by a large public. We hasten to add that the book also contains many original observations on the transmission of sound, and revises some of the views on that subject usually found in text-books. Take, for instance, the belief that clouds can produce echoes. Mr. Bacon says that he has "never obtained an echo from a cloud, either from a hollow of such cloud, from the under surface of a cloud canopy, or from the upper surface of a cloud floor." No sky or cloud echoes were observed by him even under the most favourable conditions. Some remarkable observations in the whispering gallery of St. Paul's are described, and they seem to dispose of the theory that reflection from the opposite parts of the dome is the sole cause of the phenomenon exhibited by the gallery. The suggestion is made that the sound waves travel around the wall "as a ball hugs the circular end of a bagatelle board," but this analogue will not commend itself to the mind of a physicist. Incidentally, attention is called to the fact that instead of going to a window to listen to a distant sound, it is often better to open the casement and to retire back into the room. As to the action of fog upon sound, Mr. Bacon holds that though a uniform quiescent fog may offer no obstruction to sound, rolling masses of fog of varying temperature and density may impede sound waves, or even reflect them. In one of his essays, Mr. Bacon throws doubt on the statement that the sound of a bursting meteor has been heard on earth, and suggests that when such a report has been heard it probably had a terrestrial origin. We believe that no shooting-stars have ever been accompanied by explosive sounds, but surely there is ample evidence that actual meteorites and fireballs have been heard to explode. Mr. Bacon gives the impression that all meteor sounds are illusions.

"Design in Nature's Story." By Dr. W. Kidd. (Nisbet.) 3s. 6d. net.—In these days, when we hear so much of the evolution of animal organs and structures according to an assumed "adaptation" to inanimate surroundings, and of the origin of horns and antlers from the bruises produced on their heads by contests between the males of the ox and deer tribe, it is distinctly refreshing to find that there is a writer left among us who has the courage to plead for the older conception of "design" in nature, and for the direct supervision of a personal Deity over the evolution of the animal life of our globe. Whether the author has succeeded or not in proving his contention, we may well leave our readers to judge for themselves, and we will therefore be content with quoting his concluding paragraphs. After referring to the fact that plants alone extract nutriment from the soil, and that animals live upon the present or past life of plants, Dr. Kidd proceeds as follows:—"It were wearisome to elaborate this well-known fact of nature. The simple fact remains, and no scientific explanations of the 'natural' laws under which it takes place touch for an instant its striking value as a broad argument for Design in Nature. . . . The objections of Darwin, Romanes, and Milnes Marshall, by the very earnestness of the challenge, and the magnitude of the answer afforded by the whole vegetable kingdom, constitute a body of evidence against the blind mechanical force which they deify of obvious cogency."

"A Year with Nature." By W. Percival Westell. (Drane.) Illustrated. 10s. 6d.—Under this title the author has perpetuated, between handsome covers, and in an expensive form, a series of observations of nature referable to each month of the year, and previously published in various journals. We can discover no permanent value, or indeed interest in these papers, neither is there anything original in them. Indeed, Mr. Westell's observations are little more than a series of platitudes badly strung together, and it seems a pity that they were not allowed to remain in the comparative oblivion from which they have been dragged. As far as the author's qualifications for writing are concerned we judge him by his own words, for he has "not tried to cultivate any literary style," and in his opinion, the "rush and tear of present day life only allows us to sip, rather than drink, at nature's sweet fountain."

"What is Life?" By F. Hovenden, F.L.S., etc. (Chapman & Hall.) Illustrated. 6s.—No useful purpose would be served by a descriptive or critical notice of this book. The author has peculiar ideas upon some physical and biological phenomena, and he announces established truths as if they were original discoveries. We have not for some time seen a book to which the remark could be more appropriately applied that "What is new in it is not true, and what is true is not new."

"The Story of Nineteenth Century Science." By H. S. Williams, M.D. (Harper Bros.) Illustrated. 9s.—Dr. Williams is not omniscient, but he has managed to survey the field of modern science in a very creditable manner. So far as we are aware, no other single volume exists in which such a bright and connected account of the scientific progress of a century is satisfactorily dealt with in reasonable limits, and we are glad to give Dr. Williams credit for making this available. Practically every branch of natural knowledge is passed in review in separate chapters, and though the book has an American origin, there is little evidence of a more than natural tendency to attach undue importance to work done on the other side of the Atlantic. The author appears to have exercised a wise discretion in the selection of material, and to be able to weigh justly the value of the results obtained by various observers, and in different countries. He has the eye for broad principles and suggestive generalisations essential for the preparation of a successful book of this kind. The last chapter, on "Some Unsolved Scientific Problems," is a view of questions in physics and biology in the light of the results described in earlier parts of the book, and it suitably terminates the story. From internal evidence we conclude that some parts of the book were not written very recently, but we are content to let this pass. The titles of the reproductions of star clusters, on pages 71 and 81, need revision, and the picture of star spectra, on page 73, does not show a single spectrum line. The pictures of clouds are also not worthy of the text, that of stratus clouds being very bad. Notwithstanding these minor imperfections, the book is one to be purchased by everyone who desires to become acquainted with the main lines of scientific progress in the past century.

BOOKS RECEIVED.

Matriculation Directory. No. XXIX. January, 1901. (The University Tutorial Series.) (Cambridge: Burlington House.) 1s.

Report of the Hampstead Scientific Society, 1899–1900. 3d.

The Pianist's A B C Primer and Guide. By W. H. Webbe. (London: Forsyth Brothers.) 6s. net.

Michael Faraday: His Life and Work. (The Century Science Series.) By Silvanus P. Thompson, D.Sc., F.R.S. (Cassell.) 5s.

Transactions of the Royal Scottish Arboricultural Society. Vol. XVI., Part II. (Edinburgh: Douglas & Foulis.)

Debrett's House of Commons and the Judicial Bench, 1901. (Dean.)

The Complete Works of John Keats. Vol. III. Edited by H. Buxton Forman. (Glasgow: Gowans & Gray.) 1s. net.

The Self-Educator in German. (Self-Educator Series.) Edited by John Adams, M.A., B.Sc. (Hodder & Stoughton.) 2s. 6d.

Deschanel's Natural Philosophy. Part III.—Electricity. By J. D. Everett, M.A., D.C.L., F.R.S. (Blackie.) Illustrated. 4s. 6d.

The Self-Educator in Chemistry. (Self-Educator Series.) By James Knight, M.A., B.Sc., F.C.S., F.G.S., F.E.I.S. (Hodder & Stoughton.) 2s. 6d.

Museums Association. Report of the Proceedings, 1900. Edited by E. Howarth, F.R.A.S., F.Z.S. (Dulau.)

Advanced Exercises in Practical Physics. By Arthur Schuster, Ph.D., F.R.S., and Charles H. Lees, D.Sc. (Cambridge: University Press. London: Clay.) Illustrated.

An Introduction to Modern Scientific Chemistry. By Dr. Lassar-Cohn. (Grevel.) Illustrated.

Zoological Results during the Years 1895, 1896 and 1897. By Arthur Willey, D.Sc.(Lond.), Hon. M.A.(Cantab.). Part V. (Cambridge: University Press.) Illustrated. 21s.

Return, 1900, County Council Scholarships. (Eyre & Spottiswoode.)

Symons's Meteorological Magazine. February, 1901. (Stanford.) 4d.

The Studio. Vol. 22, No. 95. February 15th, 1901. Monthly, 1s.

Differential and Integral Calculus for Beginners. By Edwin Edser, A.R.C.S., F.Ph.S. (Nelson.) 2s. 6d.

The Journal of the Society of Comparative Legislation. December, 1900. Edited by John Macdonell, C.B., LL.D., and Edward Manson. (Murray.) 5s. net.

The Cambrian Natural Observer. Edited by Arthur Mee, F.R.A.S. February, 1901. (Annual subs., 2s. 6d.)

A Manual of Elementary Science. By R. A. Gregory, F.R.A.S., and A. T. Simmons, B.Sc.(Lond.). (Macmillan.) Illustrated. 3s. 6d.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

The Migration of the Song Thrush.—Referring to the note in Knowledge for January, on the "Migrations of the Song Thrush," I am able by recent observation to confirm one statement made there, viz.: "In the winter (from October to February) we have a different kind of migration. These movements are entirely due to outbursts of cold or bad weather." During the evening and night of January 8th one of these outbursts of cold weather took place, and the next morning the whole country hereabout was covered with snow. During the morning, and lasting for about two hours, I witnessed the largest migration of Thrushes that I have ever seen, and I called the attention of several to the most unusual sight. The stream of Thrushes was continuous but irregular, and it passed directly over the town in the direction of the sea coast—about twenty miles distant. Some thousands of birds passed over, sometimes in single stragglers, and at others in dense flocks of hundreds.—E. Sillence, Romsey, February, 1901.

Snowy Owl in Co. Donegal (*Irish Naturalist*, February, 1901, p. 50).—Mr. Robert Patterson records that a female Snowy Owl (*Nyctea scandiaca*) was shot on December 15th last by Mr. John Olphert's keeper, at Bally-Connell House, Falcaragh. The remains of a rabbit were in the bird's stomach. The Snowy Owl is a rare and uncertain visitor to Ireland.

King-Eider in Co. Down (*Irish Naturalist*, February, 1901, p. 50).—Mr. Patterson also records that on November 10th, 1897, a mature male King-Eider (*Somateria spectabilis*) was shot in the Foreland Bay, off Donaghadee, by Mr. Wm. H. Shaw. The King-Eider is a very rare winter visitor to Ireland. We believe that this is the first adult male that has been recorded.

A Young Cuckoo on Migration (*Irish Naturalist*, February, 1901, p. 50).—Mr. Richard M. Barrington's systematic investigations into the records made at his instigation by Irish lighthouse keepers of the birds which strike the lanterns, have produced many valuable and interesting results. The latest find he records here. The leg and wing of a young Cuckoo have been sent to him from the Skulmartin Lightship, Co. Down. The bird was killed by striking the light on November 26th, 1900. Young Cuckoos sometimes remain here until October, and one was killed at the Tuskar Light, off the west of Ireland, on November 2nd, 1883; but November 26th is an extraordinarily late date. It is probable that the bird was bred somewhere up in the high north.

Grey Phalarope in Lincolnshire (*The Naturalist*, February, 1901, p. 42).—Mr. J. Conway Walter records that a bird of this species was shot near Kirton-by-Boston on November 9th, 1900. The Grey Phalarope is a rather irregular visitor to Great Britain, and when it does visit us it is extremely rarely found on the east coast of England north of Norfolk.

Long-eared Owls as Anglers (*The Naturalist*, February, 1900, p. 42).—Mr. Max Peacock describes a very interesting angling performance by Long-eared Owls which he witnessed some time ago in the parish of Bottesford, Lincolnshire. A pair of these Owls had a nest in a fir-tree near a mill. In the evening when the water-wheel stopped the Owls began to fish. The birds in turn swooped down into the shallow water (some 2½ inches deep), captured a fish—dace, some 3 to 5 inches in length—and flew off with it to the nest tree.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

XUM

FINGER-PRINTS AS EVIDENCES OF PERSONAL IDENTITY.

By R. Lydekker.

In the gradual and imperceptible transition from childhood to old age almost all parts of the human frame are subject to a certain amount of alteration, either in form or in structure, so that it is matter of extreme difficulty to find any one feature by which an individual may be distinguished with absolute certainty from among all his fellow men. A remarkable exception to this tendency to change is, however, exhibited by the minute ridges and grooves on the balls of the fingers, which, as explained in the article on "Monkey Hand-Prints," are arranged in a number of minute concentric lines forming characteristic patterns. In all monkeys, with the exception of some of the man-like apes, the patterns formed by these papillary ridges, as they are termed, are of a comparatively simple type. The patterns of monkey finger-tips are indeed arranged in simple flexures, which come under the denomination either of "loops" or "arches," according to the classification employed in the deciphering of human finger-prints. Such a "loop" is shown in Fig. 1, which

Fig. 1.—Impression of Middle Human Finger, displaying the looped arrangement of the papillary ridges.

represents the impression of the middle finger of a human hand. In an "arch" the flexure is still simpler, and does not exhibit that marked inclination to one side or the other which forms such a characteristic feature in loops.

In a large number of human fingers a still more complex type of flexure is observable in the ridges, which

Fig. 2.—Impression of Fore, Middle, and Ring Fingers of a Right Human Hand.

assume a kind of vortex arrangement around a central nucleus. This type is denominated a "whorl," and is beautifully displayed in Fig. 2, which shows the prints made by the fore, middle, and ring fingers of a right human hand. Still more complicated patterns may be produced by the mingling of two whorls, or of a whorl and a loop, or a whorl and arch in the same finger; such types being designated as "composites." Whorls and composites being obviously more complex than loops and arches, it is interesting to note that they are unknown in ordinary monkeys; and the gradual progression in complexity of pattern from these latter through the man-like apes to man himself is just what would have been expected to occur if the doctrine of evolution be true. It has not yet been ascertained whether the presence of arches and loops is more common in the finger-tips of the lower races of mankind, while whorls and composites are relatively more numerous among nations of higher cultivation, but it is possible that this may eventually prove to be the case. As the result of the examination of the finger-tip impressions of a very large number of Europeans and natives of India, it appears that about five per cent. come under the denomination of arches, while sixty per cent. are loops, and thirty-five per cent. whorls and composites; the proportion of each varying considerably in the several digits. For the purposes of forming a classification of finger-prints, arches, being so few, may be reckoned as loops, while composites may be included in whorls, thus giving only two types to deal with.

But before going further a few words are advisable as to the manner in which finger-prints are taken. The fingers are first pressed on a plate of tin which has been evenly and thinly coated with printing ink, and may be then pressed on suitable paper in such a manner as may be thought desirable, when, if due precautions to avoid smudging are taken, clear prints similar to the originals from which the accompanying figures were reproduced will be obtained. When the tips of the fingers are merely pressed on the paper without any other movement, the print is termed a plain one, as in Figs. 1 and 2; and it is manifest that when (as in the case of the latter) the impression of three or more figures is taken simultaneously it must be of this nature. But such a print displays only the central portion of the pattern of each finger; and in order to obtain the pattern of a larger area of the finger-tip recourse is had to another plan. To take a rolled impression, as it is called, one finger only is inked at a time, and when coated with ink is laid on the paper in such a position that the nail is in a vertical plane, after which it is rolled on the paper across the ball till the nail is again vertical. Two complete series of such rolled impressions are exhibited in Figs. A and B. It will be seen that they are taken in the natural order, commencing with the right hand, and passing from the thumb to the little finger; and then repeating the process with the left hand, the impressions from which are placed below those of the corresponding digits of the right hand. Of course such impressions are always taken in the presence of a responsible officer; but to prevent the possibility of fraud, "plain" impressions of the fore, middle, and ring fingers of each hand are taken at the same time on the same sheet as the "rolled" impression. As an additional precaution, the three fingers in question are thrust through a frame having three apertures before they are inked, and the impression is taken while they are thus fixed. The three plain impressions shown in Fig. 2 are those of the three central fingers of the right hand of the individual marked B (see figures), and they will be seen to correspond exactly with the middle portions of the rolled impression. Such correspondence is quite sufficient to indicate that the rolled impressions have been taken in their proper sequence and belong to the same individual.

For the purpose of identifying individuals by means of their rolled finger-joints, arranged in the foregoing order,

A.—Classification No. $\frac{1}{3} - \frac{U}{O}$.

RIGHT HAND.

Right thumb. \ Right index. \ Right middle. \ Right ring. \ Right little. \

LEFT HAND.

Left thumb. / Left index. W Left middle. / Left ring. / Left little. /

B.—Classification No. $\frac{32}{32} - \frac{I.I.}{O.M.}$

RIGHT HAND.

Right thumb. W Right index. W Right middle. W Right ring. W Right little. W

LEFT HAND.

Left thumb. W Left index. W Left middle. W Left ring. W Left little. W

an ingenious scheme has been invented by Mr. E. R. Henry, Chief Commissioner of Police in Bengal.

Those impressions showing whorls (or composites) are marked with the letter W. Loops, on the contrary, are indicated by oblique lines, sloping in the direction taken by the loop itself. When, for example, the palm of the

right hand being on a table, the downward slope of the ridges forming the loop is from the thumb towards the little finger, the slope is said to be ulnar, on account of running towards the ulna, or larger bone of the fore-arm. In the right hand of individual A (see figures) all the slopes are ulnar. When the loops in the right hand take the opposite direction, that is to say when they incline from the little finger towards the thumb, they are said to be radial, on account of pointing towards the radius, or smaller bone of the fore-arm. It will be obvious that the direction of ulnar and radial slopes will be the reverse in the left hand of what it is in the right; consequently all the loops in the left hand of individual A will likewise be ulnar. Hence the individual in question shows no radial loop at all.

In the formula adopted for the division of finger-prints into primary groups, all loops, whatever their direction (as well as arches), are indicated by the letter L. The digits are then taken in pairs as follows, viz.:—

$$\frac{\text{Right thumb.}}{\text{Right index.}} \quad \frac{\text{Right middle.}}{\text{Right ring.}} \quad \frac{\text{Right little.}}{\text{Left thumb.}}$$

$$\frac{\text{Left index.}}{\text{Left middle.}} \quad \frac{\text{Left ring.}}{\text{Left little.}}$$

And the letter L or W substituted for the names of the fingers themselves, according as their respective impressions show loops or whorls. Following this arrangement, the formula of the finger-prints made by individual A will be

$$\frac{L}{L} \quad \frac{L}{L} \quad \frac{L}{L} \quad \frac{W}{L} \quad \frac{L}{L}.$$

In individual B, on the contrary, the formula will be

$$\frac{W}{W} \quad \frac{W}{W} \quad \frac{W}{W} \quad \frac{W}{W} \quad \frac{W}{W}.$$

This, however, does not help much in making a workable scheme of classification, and the following plan has consequently been proposed. Whenever a whorl (W) occurs in the first of the five pairs, it is allowed to count as 16; if it occurs in the second pair its value is 8; if in the third pair 4, if in the fourth 2, and if in the fifth 1. Consequently the numerical value of individual A will be

$$\frac{0}{0} \quad \frac{0}{0} \quad \frac{0}{0} \quad \frac{2}{0} \quad \frac{0}{0} = \frac{2}{0},$$

while that of individual B will work out as

$$\frac{16}{16} \quad \frac{8}{8} \quad \frac{4}{4} \quad \frac{2}{2} \quad \frac{1}{1} = \frac{31}{31}.$$

To each value thus attained $\frac{1}{1}$ is added, and the fraction* being inverted, what is known as the primary classification number is obtained. Accordingly, in individual A we have $\frac{2}{0} + \frac{1}{1} = \frac{3}{1}$, and by inversion $= \frac{1}{3}$; while in B we have $\frac{31}{31} + \frac{1}{1} = \frac{32}{32}$.

It will be obvious that individual B presents the highest possible formula, every one of the digits exhibiting a whorl. Individual A, on the contrary, displays very nearly the lowest possible formula, which would occur when there were loops in every digit, in which case the formula would be $\frac{0}{0} + \frac{1}{1} = \frac{1}{1}$.

Consequently all possible combinations of loops and whorls may be indicated by formulæ varying in value between a minimum of $\frac{1}{1}$ and a maximum of $\frac{32}{32}$.

* Although, of course, not really a fraction, it is sometimes convenient to speak of the value as such.

But in the first pair of digits the number of combinations of loops and whorls that it is possible to have are four, that is to say we may have any one of the following four values, viz.: $\frac{L}{L}$, $\frac{L}{W}$, $\frac{W}{L}$, or $\frac{W}{W}$. And since (to paraphrase from Mr. Henry's book on finger-prints) the same number of combinations occur in the second pair of digits, and as each of these may be combined with each and every arrangement obtaining in the first pair, the total number of possible combinations in these two is sixteen. But the third pair of digits has likewise four possible arrangements, which, taken with those of the first and second pairs, raise the number to 64. By adding the combinations to the fourth pair, the number rises to 2256, and with the inclusion of the fifth pair to 1024, which is the square of 32. Consequently a square cabinet containing 32 tiers of 32 compartments each will suffice for the accommodation of all the groups into which finger-prints are divisible according to the primary classification.

But it is obvious that there may be a very large number of individuals in whom the patterns on the fingers are expressed by the formula $\frac{1}{3}$ or $\frac{32}{32}$; and as a matter of fact the largest accumulations do occur in the case where there are either all loops $\left(\frac{1}{1}\right)$ or all whorls $\left(\frac{32}{32}\right)$. Consequently sub-divisions of these great groups are essential. And a secondary classification has been invented, depending, in the case of the lower values, on the occurrence of arches or in the direction of the loops in certain digits, or, in the case of the higher values, on the manner in which the individual lines are arranged in the whorls or composites. To enter in detail into this secondary classification would be quite out of place, and those who would study the subject seriously must consult Mr. Henry's book.

In the lower values attention is paid to the circumstance whether the index fingers show an arch, a radial, or an ulnar loop, or, when they have a whorl, as to the arrangement of the central lines. In cases where whorls are absent, and the formula is consequently $\frac{1}{1}$, both index fingers may show an arch, when the formula will be $\frac{1}{1}, \frac{A}{A}$, or a radial loop, when it will be $\frac{1}{1}, \frac{R}{R}$, or an ulnar loop, when it will be expressed as $\frac{1}{1}, \frac{R}{R}$. And there may, of course, be any combinations of these, such as $\frac{1}{1}, \frac{A}{R}$. In the individual indicated as A, in the figure, whose primary formula is $\frac{1}{3}$, it will be seen that the right index has an ulnar slope; while in what are known as the deltas of the whorl in the left index, a certain line takes a course external to another, and is consequently classed as outer, with the symbol O. The full classification formula of individual A will therefore be $\frac{1}{3} - \frac{U}{O}$.

Turning to individual B, the characteristic delta-line in the right index is internal, while in the left index it is external or outer, this being indicated by the symbol $\frac{I}{O}$. Again, in the right middle finger the distinctive delta-line is internal, while in the corresponding digit of the left hand it is median in position, this being expressed as $\frac{I}{M}$. Consequently the complete classification number for individual B will be $\frac{32}{32} - \frac{I.\ I.}{O.M.}$.

It will thus be seen that by paying attention to minute points, the larger accumulations of sheets may be broken

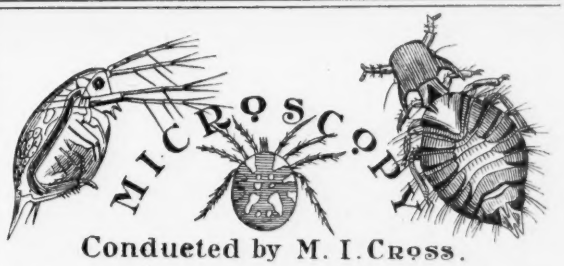
up into such a number of minor groups that there will be little difficulty in assigning to its proper serial position each new record that is added, or in identifying duplicate impressions of the same individual. When the classification numbers of any two or more sheets agree, even as regarding the letters denoting the secondary characteristics, they may be differentiated by comparing together (with the aid of a lens) the prints of each individual finger, where a number of minute but characteristic peculiarities will be sure to be detected, which will serve to distinguish the two records.

The method of the identification of individuals by means of this ingenious system is, of course, perfectly simple. Where it is in use, as in India, the finger-prints of every individual who is convicted in the law-courts are taken and duly pigeon-holed or filed, according to the classification described above. When any individual, previously unknown to the police of the district, is charged with an offence, his finger-prints are immediately taken and duly classified. Reference is then made to the corresponding group of classification-numbers in the cabinet or file, and if an absolutely identical impression is found, the whole history of the individual is at once made known. If the duplicate of his impression is not in the series, it is evident that the accused is "unknown to the police," and he is therefore entitled to the benefit of the "First Offenders' Act," or its Indian equivalent.

But this is not all. Occasionally a burglar, by cutting his hand, or by smearing it with ink or some other substance, may leave the impression of one or more of his fingers on some article in the house. And Mr. Henry, in a paper read before the British Association at Dover in 1900 (to which we are indebted for the information embodied in this article), gives an instance of this nature which led to the identification and conviction of the criminal. Briefly stated, the case was as follows:—The manager of a tea estate in the Julpárguri district was found foully murdered, his despatch box, in a rifled condition, lying near the body. In this box was an almanack marked with two faint brown smudges. By chemical examination these were proved to be made by human blood, while, by the aid of a magnifying glass, one of them was discovered to be the print of a human thumb, which was subsequently identified as that of a certain individual whose finger-record had been filed by the Bengal police. The evidence was considered by a native jury sufficient to convict the accused of theft, although (somewhat inconsequentially) not of murder, and he was accordingly sentenced to a term of imprisonment.

Other systems of classification of finger-prints have been prepared, but, in our opinion, none are equal in simplicity and convenience to that invented by Mr. Henry. As already said, it has been adopted in India, and it might, we think, be advantageously used in this country.

In addition to their value as a means whereby suspected persons may be readily and undisputably identified, finger-prints have, however, as already indicated, a very considerable degree of interest to the naturalist. They serve to show that even in such minute details as the arrangement of the ridges on the skin of his finger-tips man has attained a higher degree of specialisation than the lower monkeys, and that certain of the man-like apes alone approximate to him in this respect. The subject is, however, still in its infancy, and further interesting results will doubtless accrue from a more extended investigation one of the points to determine being, as already indicated, whether "whorls" are more predominant on the finger-tips of the higher as compared with the lower races of mankind.



Condueted by M. I. CROSS.

BRITISH VERSUS CONTINENTAL MICROSCOPES.—For accurate original research, where the worker has some understanding of the mechanical and optical means at his disposal, there is no microscope in the world to be compared with the best of those produced by the leading British houses. In them are to be found refinements of mechanical skill which, suitably employed, call forth a response from objectives and condensers which causes them to yield their very best effects. Even in the British models of medium size and at modest cost there are to be found several that are but slightly less effective than the largest, and with which no Continental stand can vie.

Yet the British microscope plays but an insignificant part, numerically, in the world's supply. In laboratories and in places where microscopes are largely used, the Continental instrument holds sway and seems likely to maintain it, at any rate for the present. The question of price is not the factor in the existing state of things, for even in student's stands the British manufacturer keeps his rates at the competitive mark. Why then is it that he does not receive a larger share of appreciation and support?

The reasons usually given appear to be two in number, and are—

1. The British microscope exceeds the needs of the laboratory worker and student;

2. The casing and general "fit up" is inferior.

The first is distinctly a laboratory cry, and may be regarded as due to want of appreciation and education in matters microscopical. The second is more general in its application and in a lesser degree influential.

To do the largest amount of work in the least possible time with the most cut and dried materials is a spirit which pervades the present day, and it applies to microscopical as much as to other spheres of activity.

The laboratory worker wants as much done for him as possible, so that it may only be necessary for him to place his object on the stage and "spot" the structure. To get the best from lenses and condenser is not in his province. "Numerical aperture," "aplanatic cone," and "critical image" are, as a rule, vague terms to him. Hence it comes that an instrument that always has its substage condenser approximately focussed and centred, and the mirror fixed in the line of the optical axis, saves him time and bother and suits his methods of working.

No one can defend the use of what are in reality but rough and ready means of examination of structure, and no reliance can be placed on deductions made from such methods. We are among those who are sanguine enough to hope that in the no very distant future, the advantage of perfect control in manipulation, and a rigid tripod foot, as provided in the majority of British microscopes, will supersede the Continental model.

This can only be brought about by a demand for more thorough teaching of microscopical principles and manipulation, and if good work is to be done in English laboratories it should be seen to that those who use the instruments shall get the best possible out of them. If this necessity were recognised and taken up vigorously by the scientific world—and many know full well how much it is needed—a different state of things would in time prevail. We would not advocate the pandering to a low degree of appreciation by reducing either the calibre or working accuracies of the instrument. Let us all do our best to raise the users to a higher level.

Meanwhile, the British manufacturer has opportunities of making his instruments more acceptable in several ways, and especially in the casing and general "fit up."

A great improvement has taken place in recent years, but there is yet room for further effort. Generally speaking, British houses are inferior to their Continental rivals in this

respect. It must be remembered that the horseshoe foot is more easily gripped and held firmly in its case than the tripod, but a strong and neat fitting for the latter ought not to be beyond the powers of the ingenious to contrive.

It may be fearlessly stated that a good day is coming yet for British microscopes if the makers do but set their house in order, and in addition to providing the most sound and accurate instrument that can be, they give due consideration to every detail which will make them acceptable to those who are influenced by appearance. There is no disgrace in making a microscope and its case ornamental as well as useful.

STAINING LIVING BACILLI.—We have had placed in our hands an interesting paper by Mons. A. Certes dealing with the selective colouring power of the spore-bearing filaments of the *living Spirobacillus gigas* with methylene blue, and the following is a brief *résumé* of it.

He remarks that the experiments of Brandt, Henneguy and himself, dating from 1881, prove that living protoplasm can absorb certain aniline colours, but little has been done by biologists in the study of the action of colouring substances on living microbes. It has been found that certain microbes cease to live on being stained, others absorb the stain and still remain alive, while others do not absorb the stain either alive or dead.

The difficulty of making observations on selective coloration is obvious on such delicate subjects as bacteria, but M. Certes was fortunate in discovering the *Spirobacillus gigas* in the reservoirs at Aden; the length of these is usually 150—160 mikrons, but they are occasionally found 400 mikrons long.

These organisms placed in a weak solution of methylene blue continue to move about with the same activity as before, and the stained specimens can be preserved alive until the following day if care be taken not to exclude oxygen.

The effect of the stain varies according to the stage of development of the bacilli. During the first two or three days the living specimens are entirely and uniformly stained in blue exactly like dead specimens.

When the period of sporulation commences, alongside of the totally stained bacilli, the presence of bacilli of different shapes is observed, partially stained and much more clearly. In the same specimens are coloured rings in juxtaposition to uncoloured rings, grouped in the most varied manner and without any apparent fixed rule.

The spore-bearing individuals which appear a little after, give the clue to these selective coloration phenomena, which acquire a still greater clearness when the specimens are larger—as the turns of the spiral are less serrated, and the spore-bearing bacilli move more slowly in zig-zag fashion. One sees, therefore, that the spores, while refractive, have, except in rare cases, absorbed the colouring matter. and that the filaments which carry them are, in general, more feebly coloured, sometimes even uncoloured, and that in those specimens whose spores are localised at one extremity on a fixed point on the filament, the rings which carry the spores are almost always uncoloured.

Success largely depends on the colouring re-agents that are used. The finest quality of Ehrlich's blue and the chemically pure methylene blue of Grübler and Höchst in very weak solution are recommended, and they should be used at the precise moment when the first sporule-bearing individuals appear.

These phenomena are only visible in the living state; dead specimens stain so rapidly and uniformly that it is extremely difficult to obtain preparations in which the differentiated coloration is distinctly visible.

NEW APPARATUS DESCRIBED BY MANUFACTURERS.—We have received from Messrs. A. E. Staley & Co., of 35, Aldermanbury, London, some very interesting notes regarding the microscopes and accessories manufactured by *The Bausch & Lomb Optical Co., Rochester, New York, U.S.A.*

It is, unfortunately, impossible to reproduce the details in their entirety, but we have much pleasure in calling attention to the fact that Messrs. Staley have been appointed agents for Great Britain for these famous instruments.

A perusal of the English edition of Messrs. Bausch & Lomb's catalogue discloses the fact that prices have been considerably modified for the English market.

Those who have a preference for the Continental type of stand will find an assortment of these of varying sizes, while microscopists who are interested in objectives and apparatus will find it well worth their while to peruse the handsome catalogue.

The Bausch and Lomb microscopes have a great reputation in the United States, and are, undoubtedly, soundly constructed, well finished, and in the English catalogue moderately priced.

W. Watson & Sons, 313, High Holborn, W.C.—A new form of sterilizable needle for blood examination, designed by Drs. Slater and Spitta. It is of metal throughout, can be sterilized, and remains so when carried in the pocket. It is self-contained, and carries a reserve of lancet-pointed needles in its recessed end

NOTES AND QUERIES.—*Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to* M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

GIACOBINI'S COMET.—The small comet discovered at Nice, on December 20th, was very faint, and it had already passed its perihelion. Becoming fainter with increased distance from the earth it was only observed in large telescopes, and has now practically passed beyond the range of visibility. From observations between December 24th, 1900, and January 14th, 1901, Prof. Kreutz, of Kiel, finds that the comet revolves in an elliptic orbit, with a period of about 6·88 years, so that it belongs to the Jovian family. It passed through perihelion on November 28th, 1900, and the elements of its orbit bear a resemblance to those of Wolf's comet of 1884, and Barnard's comet of 1892. The comet being a periodic one of interesting character, it is to be hoped that position-observations will be secured over a sufficiently long interval to enable a good definitive orbit to be derived from them. On March 6th the place of the comet will be R.A. 4h. 7m. 53s., Dec. 10° 1′ S., so that it will be near Mira Ceti.

BRORSEN'S COMET.—This object ought to be fairly well visible in March, but in view of the fact that its continued existence is somewhat questionable, we cannot look forward with confidence to the re-appearance and discovery of the comet. First seen by Brorsen at Kiel on February 26th, 1846, it was found to be revolving in an elliptical orbit with a period of about 5½ years, and it was satisfactorily re-observed in 1857, 1868, 1873, and 1879, but escaped notice at the last three returns in 1885, 1890, and 1896. Should the comet elude detection during the present spring there will be no alternative but to conclude that, like the double comet of Biela, it must be numbered with the lost comets. Hind pointed out in *Ast. Nach.*, 3271, that the orbit of Brorsen's comet and of Denning's comet (I. 1894) intersect in long. 285, and that in April, 1881, the two objects must have been close to one another near the point of intersection. He was led to the conjecture that Brorsen's comet, on its recession from perihelion after it was last observed in 1879, may have met with a catastrophe, bringing about its disintegration and causing one portion of it to return in the aspect and orbit of Denning's comet of 1894. Dr. Schulhof supported these conclusions, and pointed out (*Ast. Nach.*, 3276) that the point of intersection of the two orbits coincides with the place of their nearest approach to the planet Jupiter. Dr. Lamp has also examined this interesting question, and found that the two comets passed through the corresponding points of their orbits on January 17th and January 23rd, 1881, respectively. The least distance between the two orbits was 199 radii of the earth. There is very little doubt therefore that a close conjunction of the two comets occurred early in 1881, but whether or not this indicates the actual disintegration of Brorsen's comet on that occasion is open to question. The approach of the two bodies may have been quite accidental. In any case, the re-detection either of Brorsen's comet of 1846 or of Denning's comet of 1894 will be important, as affording materials for the further investigation of the idea of their connection.

DAYLIGHT FIREBALL OF JANUARY 6TH.—This object, which appeared in bright sunshine, 52 minutes after noon, was quite of an exceptional character. It was observed by several persons in Glasgow. "T. H." says he was walking along Great Western Road a few minutes before 1 p.m. when the meteor flashed across the north-western sky. "L. D" describes the object as bursting like a ball of fire among the hedges near the Catholic cemetery as observed from Lambhill Road. Another writer noticed it from Whiteinch Park, and states that its flight was in the direction from N.E. to W. It was not like an ordinary falling star, but resembled a rocket with a long streaming tail. It apparently exploded on Scotstownhill. As seen from Rosneath the meteor appeared as a ball of fire with a tail. It darted between the trees in a westerly direction about 20 feet off the ground. At Crossmylcof it looked like a rocket flying in a north-westerly direction. It was of considerable size, the glowing mass forming the head being as large as a bowling ball with a fiery tail attached. At Durisdeer, Dumfries, "J. W. W." refers to the meteor as a large silver ball, with a long tail, appearing in a north-westerly direction. At Craighat, Killearn, N.B., the object vanished 12° above

W.N.W. horizon, after a path of 20° or 25° in a direction from N.W. The path was slightly descending, the altitude being about 5° less at the end. The brilliancy of the object was estimated three times that of Venus at her best, and the nucleus threw off a crimson tail 4° in length.

RECENT FIREBALLS.—Brilliant meteors of this class have been reported on following dates:—

		H.	M.	
January	10 ...	7	18	a.m., Penshurst, Kent.
	13 ...	10	44	p.m., Beaminster, Dorset, and London.
	24 ..	6	55	p m., Edinburgh.
	28 ...	9	22	p.m., Dumfries and Edinburgh.
	29 ...	7	30	a.m., Bristol.
February	7 ...	8	4	p.m., Felixstowe.
	12 ...	7	40	p.m., Llanelly.

Further descriptions of the observed paths of these bodies would be interesting.

JANUARY METEORIC SHOWER, 1901.—The prevalence of moonlight and cloudy weather has probably enabled the meteors of January 2–3 to elude observation this year. Nothing of them was seen at Bristol, and no reports have been received of successful observations elsewhere.

THE FACE OF THE SKY FOR MARCH.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.49 A.M., and sets at 5.37 P.M; on the 31st he rises at 5.41 A.M, and sets at 6.28 P.M. The sun enters Aries, and Spring commences on the 21st at 7 A.M. Few sunspots are to be expected. During this month the Zodiacal Light is favourably placed for observation in the western sky after sunset.

THE MOON.—The moon will be full on the 5th at 8.4 A.M., will enter last quarter on the 13th at 1.6 P.M., will be new on the 20th at 12.53 P.M., and will enter last quarter on the 27th at 4.39 A.M. The following are among the more interesting occultations which occur during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Mar. 2	κ Cancri ...	5·0	10.46 P.M.	122	116	12·3	289	267	11 21
,, 24	ω^1 Tauri ...	5·8	7.37 P.M.	89	49	8·40	268	227	4 7
,, 25	4 Tauri ...	5·5	6.32 P.M.	84	58	7·42	282	245	5 6
,, 26	68 Orionis ...	5·6	9.15 P.M.	63	24	10·6	319	278	6 9
,, 28	1 Cancri ...	5·9	6.16 P.M.	34	53	6·40	359	12	8 5
,, 29	A^2 Cancri ...	5·8	5.30 P.M.	142	174	6·33	256	278	9 5

THE PLANETS.—Mercury is in inferior conjunction on the 7th, and will afterwards be a morning star, but unfavourably placed for observation in our latitudes.

Venus remains a morning star, but too near the sun for naked-eye observations. She is approaching superior conjunction.

Mars can be observed throughout the night, his path being a westerly one through Leo to the north of Regulus. He crosses the meridian on the 1st at 11.38 P.M., and on the 31st at 9.12 P.M., the apparent diameter on these dates being respectively 13″·8 and 11″·6. The phase is of course almost inappreciable, the illuminated part of the disc on the 15th being 0·979.

Jupiter can only be observed in the morning, rising about 4.5 A.M. on the 1st, and 2.20 A.M on the 31st. His path is a short easterly one through Sagittarius, and the meridian altitude in London is less than 20 degrees.

Saturn is also in Sagittarius, a little to the east of Jupiter. On the 1st the planet rises about 4.25 A.M., and on the 31st about 2.35 A.M.

Uranus is in the most southerly part of Ophiuchus, nearly 4 degrees to the north-west of θ, and, like Jupiter and Saturn, can only be observed in the mornings. On the 1st he rises about 2 30 A.M., and on the 31st about 12.34 A.M. The planet is in quadrature on the 8th, and stationary on the 22nd.

Neptune may still be observed until after midnight. He is stationary on the 8th, and in quadrature on the 17th. On the 1st he crosses the meridian at 7.9 P.M., and on the 31st at 5.12 P.M. He remains nearly midway between χ^1 Orionis and 132 Tauri.

THE STARS.—About 9 P.M., at the middle of the month, Aries will be setting a little north of west; Taurus will be nearly due west; Orion in the south-west; Capella high up in the west; Sirius low down about 30° south of west; Procyon and Gemini higher and a little nearer the meridian; Cancer on the meridian; Leo pretty high up in the south-east; Arcturus to the east; Hercules and Lyra low down in the north-east.

Minima of Algol occur at convenient times on the 10th at 9.52 P.M., on the 13th at 6.40 P.M, and on the 30th at 11.35 P.M

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of February Problems.

No. 1.

(W. H. Gundry.)

1. Kt to Kt5, and mates next move.

No. 2.

(B. G. Laws.)

Key move—1. B to K3.

If 1. . . . P to K4, 2. Kt to Q6ch., etc.
1. . . . K to Q4 or R × P. 2. Q to Kt7ch.
1. . . . P × Kt, 2. Q × Pch., etc.

[There is, unfortunately, a second solution by 1. . . . B to Q6, threatening 2. Q to Kt7ch.]

CORRECT SOLUTIONS of both problems received from W. de P. Crousaz. J. Baddeley, Alpha, B. Harley, G. A. Forde (Capt.), F. J. Lea, G. Groom, C. F. P., C. C. Massey, W. H. S. M., J. T. Blakemore, (6), W. Nash, C. C. Pennington, N. L. Gillespie, S. G. Luckcock (6), E. Hunt, A. J. Head, Endirby, Vivien H. Macmeikan, J. Sowden, N. Buchanan, W. Jay (6), G. W. Middleton, Eugene Henry, H. S. Brandreth, N K. Dutt, A. E. Whitehouse, F. A. Wilcock (6), W. B. Alldritt, A. W. Tyer, J. M. K., C. Child, H. Le Jeune, A. H Machell Cox, J. E Broadbent, G. W. (6), C. Johnston (6), H. Boyes, A. Jackson, A. C. Challenger (6), A. Dod (6), W. Smith, C. S. Hudson, S. W Billings (6), F. Dennis

All the above score 5, except where otherwise stated.

Of No. 1 only from H. W. Eleum. Of No. 2 from J. A. Nicholson.

For the first time probably in many years *no incorrect solution* to either problem has been received.

W. Jay.—See reply to "Endirby" below. A solution in less than the stipulated number of moves would count as an ordinary "cook." One other key, if there be one, should be sent with it.

F. A. Wilcock.—A very successful first appearance

Endirby.—Nothing can be gained by sending more than two keys to any problem.

W. Nash.—Yes, your card gives 1. QQB3. I much regret your slip.

J. Baddeley.—Probably not; but if such a course should be deemed advisable, a suitable warning will be given.

E. Hunt.—Problems with more than one key may *possibly* be given intentionally in the later stages of the competition.

S. W. Billings.—It is not necessary to give more than two keys to any problem, or to say which is the author's intention.

C. S. Hudson.—You will see that your suspicions are correct. Considering the reputation of the composer it is strange that these suspicions were not shared by the large number of other solvers who gave B to Q6 only.

S. S.—Too late to reply to last month. You will see that your solutions were incorrect.

W. F. P.— Solution of No. 1 correct, but Croydon postmark was February 11th.

P. G. L. F.—Many thanks. They will appear next month.

R. J. Pearce.—Your communications have been handed to me. That which is remotely connected with Chess is noticed below. Please excuse my abstract of your paper.

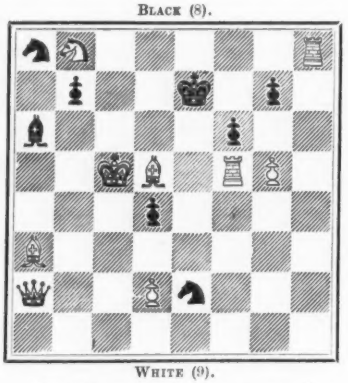
A table of the leading scores in the Solution Tourney will be given next month. Meanwhile some apology is due for the following attempts to atone for lack of difficulty by means of additional quantity.

PROBLEMS.

By C. D. Locock.

No. 1.

BLACK (8).

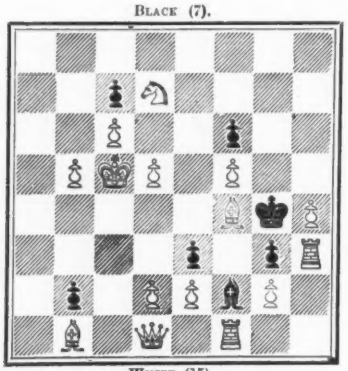


WHITE (9).

White mates in two moves.

No. 2.

BLACK (7).

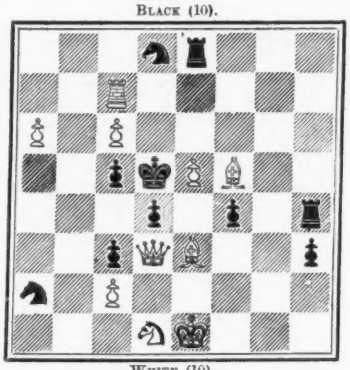


WHITE (15).

White mates in two moves.

No. 3.

BLACK (10).



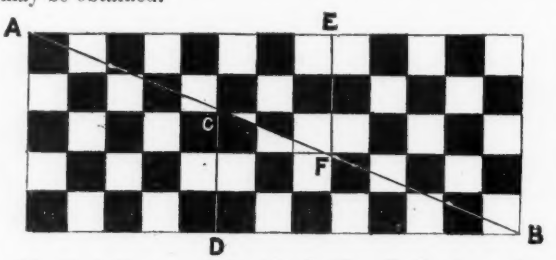
WHITE (10).

White mates in two moves.

CHESS INTELLIGENCE.

AN OLD CHESS-BOARD PUZZLE.

Probably most chess-players are acquainted with the device by means of which a chess diagram may be cut into four pieces and fitted together in such a manner as to form a rectangle of apparently 65 squares. The method is as follows: Cut off the 24 top squares of a diagram, and cut that piece into two halves diagonally, from corner to corner. Then cut the larger piece of 40 squares along a line drawn from the left hand bottom corner of Qsq. to the right-hand top corner of K5. By fitting these pieces together, a rectangle, apparently 13×5, may be obtained.



Mr. R. J. Pearce, of Auckland, New Zealand, sends a mathematical exposure of the fallacy. I have not space for his proof, and am doubtful whether it would be intelligible to all the readers of this column; but the gist of the matter lies in the fact that while the "fitting" along the lines CD and EF is quite correct, the "fitting" along AB is by no means so accurate. In fact AB, so far from being a straight line, is in reality an attenuated rhomboid, ACBF, having an area exactly equal to that of one square of the chessboard. That is, the complete figure is composed of diagram paper amounting in all to 64 squares intersected by a small rivulet of ink or other paper equal in area to one square; the result being a true rectangle of an area equal to 65 squares. The difficult part of Mr. Pearce's proof lies of course in calculating the area of the parallelogram ACBF.

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